REPORT

ON

LATHYRISM

IN THE

CENTRAL PROVINCES

IN

1896—1902.

BY

MAJOR ANDREW BUCHANAN, I. M. S.

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FROM

MAJOR A. BUCHANAN, I. M. S.,

To

THE ADMINISTRATIVE MEDICAL OFFICER,

Central Provinces.

Dated Betul, the 30th October 1903.

SIR,

I have the honour to forward herewith my Report on the outbreak of Lathyrism in the Central Provinces in the years 1896 to 1902. The Report is divided into 10 chapters which are arranged as follows :—

(1) In Chapters I and II will be found some introductory remarks and description of the disease.

(2) In Chapter III a review of the theories regarding the causation of the disease and an historical review of Lathyrism in India and especially in the North-Western Provinces.

(3) Chapters IV, V and VI deal more particularly with the Central Provinces. First, a general account of the agricultural conditions of the Central Provinces is given, and then a summary of the observations which were made during my tour through the wheat and rice districts.

(4) In Chapter VII will be found a review of the literature on Lathyrism in Algeria, France and Italy and a comparison between the epidemics in these countries and the epidemics in India.

(5) In Chapter VIII the value of lathyrus as a food is considered, first, as regards man and second, as regards animals.

(6) In Chapter IX the question of the nature of the poison is discussed, first from a botanical point of view and then from a consideration of the poisons that are found in analagous diseases.

(7) In Chapter X will be found some remarks on treatment, prevention, and a general summary of the conclusions that have been arrived at.

I have the honour to be,

Sir,

Your most obedient Servant,

A. BUCHANAN.

LATHYRISM IN THE CENTRAL PROVINCES IN 1896-1902.

BY MAJOR A. BUCHANAN, I. M. S.

CHAPTER I.—INTRODUCTORY.

1. The name Lathyrism is applied to a form of paralysis that results from eating a kind of vetch called *Lathyrus Sativus*. A great epidemic has recently occurred in the Central Provinces, India, and a recent census shows that the number of people who have been more or less paralysed is over 7,600. When we consider that it is chiefly the adult males who are effected—the working men in a population that are chiefly cultivators; when we consider that these men are suffering, not from a temporary paralysis, but that many of them are never likely to recover, some idea of the amount of distress that is caused by Lathyrism may be formed. But apart from the actual distress, and looking at the matter from an economic point of view, if we take 2,000 men unable to work for 300 days in a year and for 30 years of their lives, we have a loss to the State of 18 million days' work.

2. Under the orders of the Honourable the Chief Commissioner of the Central Provinces, I was put on special duty on the 17th of January 1903 to enquire into the cause of the spread of Lathyrism, and to endeavour to find some means of preventing its further spread. While the enquiry was to be chiefly confined to the Central Provinces, it was suggested that enquiry might also be made in some parts of the United Provinces of Agra and Oudh, and especially at Allahabad, where a great outbreak of Lathyrism occurred 40 years ago.

3. As the subject of Lathyrism, or perhaps I should say the evil effects produced in animals which are fed on lathyrus, have excited as much, if not more, interest among members of the veterinary profession, owing to the numerous cases of disease among animals that were fed on "feeding cake" in which lathyrus was an ingredient, I had suggested that Mr. Stockman, M. R. C. V. S., late Professor of Pathology in the Veterinary School of Medicine, Edinburgh, should be associated with me in making this enquiry; but after that suggestion had been approved of by the Government of India, Mr. Stockman was appointed Principal Veterinary Officer of the Transvaal. Although he was not able to join in the enquiry, he was able to contribute a considerable number of extracts from Veterinary Literature, and he has given some valuable hints and suggestions which will be referred to later.

4. There are some points in regard to Lathyrism which can only be decided by experiment or in a laboratory well supplied with apparatus, and I had thought that this part of the work could be done well by Mr. Stockman. As the literature on the subject began to come in, and as I read of the experiments that had been made by one after another, and saw that the chief conclusion from each set of experiments was to show that the conclusions arrived at by somebody else were wrong (there are some important exceptions), I began to see that a series of experiments made in haste and in a limited time would probably lead to no definite or important conclusion, and I have therefore thought it better to submit this report without waiting for the results of any experiments that may be made, and in the hope that this report may show on what lines experiments may be conducted to the best advantage.

5. Another thing which leads me to believe that this is the best course, is the fact that the principal object of the enquiry is to find some means of preventing the spread of Lathyrism, and I believe that I can now offer suggestions which will help to stop its spread.

6. Although in the instructions which I received it was not stated that enquiry should be made into the history of previous epidemics, whether in India or in other countries, still, as I have been able to obtain a large amount of literature on the epidemics that occurred in India in former years, and also on the epidemics that occurred in France, Italy, and Algeria, I hope it will not be considered to be outside the scope of the present report, if reference is made at some length to the reports that have been written on other epidemics. I feel more justified in taking this course when I consider that some of these reports have been written by French and Italian medical men, who are recognised authorities on the subjects on which they wrote.

7. Before describing the epidemic in the Central Provinces, a short account of the epidemics that have been described by various writers may be given. It was in Europe that the disease appears to have first attracted attention. Reference had been made by Hippocrates and Galen to the "impotentia crurum" of those who fed on what was called "ervum," but we need not stop to discuss the possibility of lathyrus being included in their "ervum." The first definite mention of paralysis having been caused by lathyrus appears to have been made in 1671. In that year the Grand Duke of Wurtemberg issued an edict prohibiting its use for bread. Similar edicts were issued by his successor in 1705 and 1714. The disease was regarded as incurable, though death seldom resulted from it. In 1681 Ramazzini reported an epidemic in the Grand Duchy of Modena, and 89 years later (1770) Duvernoy wrote of it in the same place. In 1785 Tagioni Fozetti reported an epidemic in Tuscany. In 1829 Desperanches wrote a report on an epidemic in Loir et Cher. In 1847 Pelliciotti reported 30 cases in the Abruzzi. Cantani of Naples described some cases in 1873. Giorgeri described some cases that occurred in Parma in 1881, and in the same year an epidemic that occurred in Algeria was investigated by several Frenchmen.

8. The first mention that has been found in Indian literature is the description given by Sleeman in his *Rambles and Recollections* of a great epidemic in the Saugor Territories (1833), curiously enough the place where the recent epidemic has been most severe. The next epidemic of which we have a record is that in Upper Scinde, which was described by Dr. Kinloch Kirk, in 1845. Then we come to the great epidemic in the Allahabad District in 1857 and following years, when the subject was studied very thoroughly by Dr. Irving, who was Civil Surgeon of Allahabad. Several minor epidemics have occurred in the Central Provinces. In 1854 some cases occurred in Damoh. In 1877 (the year of the Madras Famine) several cases occurred in Betul, and have recently been reported by Assistant Surgeon Kane. In 1868 (the year of the Bundelkund Famine) many cases occurred in Bhandara in the wheat-growing area in Pownee, and a report was written on the cases in Bhandara by Dr. Prentie in 1893. In 1893 a small epidemic occurred in Seoni and an account of the epidemic was published by Major Hendley in the *Indian Medical Gazette* in that year.

CHAPTER II.—Description of the Disease.

9. The disease varies in severity according to the length of time during which the grain was consumed, to the quantity that was consumed daily, to the age and sex of the persons affected. If a man eats pure teora for about two months he gets cramps in the calves of his legs, and if he then stops eating the grain he may recover almost entirely, or only a little stiffness of his legs may remain. He is able to walk about without the aid of a stick, but an up and down movement of his shoulders may be noticed when he is walking. His toes may drag slightly on the ground, and if he attempts to run, this tendency is exaggerated so that he may fall. If he continues eating teora he may experience a somewhat sudden onset of paralysis and he will be laid up in bed for a few weeks. If he then stops eating teora he will improve and in a few weeks he will be able to move about, but with the aid of a long stick. His toes will scrape the ground and the muscles of the back of his legs will be rigid. If he should still go on eating teora he will lose control over the bladder and rectum sphincters and he will pass urine and stools in his clothes. If he stops eating teora he also will improve and he will be able to move about after a few months, but he will require to support himself with two sticks. A very small number of cases, the crawlers, have eaten teora for a very long time, and they are unable to stand even with the aid of sticks.

The six stages of Lathyrism.

10. Omitting the crawlers we might divide the cases of Lathyrism into six groups, *viz.*, Stage I in which the chief symptom is cramps; Stage II, in which the leading symptom is paralysis, and Stage III, in which there is paralysis plus sphincter paralysis. These are the three stages of what might be called the attack, but all have a tendency to recovery. Those who have been in Stage III will be able to walk about with the aid of two sticks—Stage IV. Those who have been in Stage II will be able to walk about with the aid of one stick—Stage V; and those who only got cramps will be able to walk about without a stick—Stage VI. A man who is in Stage IV (using two sticks) may under treatment improve to Stage V (the one stick stage), and a man in Stage V may improve to Stage VI. When dealing with large numbers this classification has considerable advantages, for if we say that a man has passed through Stages I, II, V, and is now in Stage VI, we have in a few figures a great part of his medical history. Some will be found who grip one long stick with both hands. These will be referred to as in Stage IV½.

Necessity for classification.

11. The necessity for some such classification is evident when we read the descriptions of the disease which have been given by different authors—one saying that a symptom is never present which another had found frequently. This is especially true in regard to the bladder and rectum symptoms, for only a comparatively small number have been in Stage III, and in some places we may find many that have advanced to Stages II and V but few or none that have been in Stages III and IV. It is important to remember that the severe cases show not only an exaggeration of the symptoms of the milder cases, but that they show new symptoms which are not present in the milder cases.

The teora walk.

12. The mild case has to raise his body high before the toes will leave the ground, and the up and down movement of the shoulders is the chief symptom that we notice. The more severe cases use one or two sticks, and these sticks are always long. In the stage IV cases there is often a reversed pendulum motion of the upper part of the body. One stick is put forward, and then the upper part of the body sways forward; the body becomes erect before the other stick is put forward. The dragging of the toes is the most marked symptom, and the foot-prints on a dusty road show this well. The inner side of the nail of the great toe is worn away, and in bad case the upper surfaces of the outer toes may be rubbed. There is nearly always a tendency to cross-legged progression (see photographs).

Symptoms in detail.

13. *Onset.*—The onset is often sudden, but if careful enquiry be made the patients will frequently admit that they had felt cramps or a peculiar tingling sensation in the legs for some days previously.

Progress.—After a few days or weeks, if the consumption of teora is stopped, there is a tendency to recovery.

Reflexes.—The knee jerk is increased in all cases and it may be more in one side than in the other. The foot-clonus is increased, but as a rule only in the severe cases. In the very severe cases when the patient attempts to stand he rests on tiptoes and the whole body is shaken with contractions, a sort of reversed ankle-clonus.

Rigidity.—The muscles in the back of the legs are rigid and the rigidity is specially marked in the cold mornings.

Nutrition of muscles.—The muscles are as a rule well nourished.

Arms.—I have not seen any cases in which the arms were affected.

Sensation.—Cramps at the begining may cause some pain, and in some of the severe cases there has been distinct pain in the back. Many cases have a tingling sensation in the legs at the beginning of the attack.

Bed-sores.—I have not seen or heard of any cases in which there were bed-sores.

Sphincters.—The sphincters are only affected in the severe cases (Stage III), and after a few weeks such symptoms pass off.

Sexual power.—Sexual power is always lost in those cases who pass to Stage III. It is reduced in the Stage II cases. In young men it returns, but in the old it may remain defective.

Lathyrism and Spastic Paraplegia compared.

14. The symptoms of Lathyrism resemble those of spastic paraplegia, a disease which has for some years engaged the special attention of Professor Erb of Heidelberg. In 1875 he described what he called the "Symptom Tryad"—weakness of the lower extremities, muscular rigidity of the same region, and marked increase of the tendon reflexes. In 1892 he described a second clinical form of the disease which he thought was confined almost exclusively to those who had previously suffered from syphilis. In addition to the Symptom Tryad, there was always a disturbance of the bladder function, especially incontinence, and usually some weakness of the generative organs. It is interesting to note that the severe cases of Lathyrism (Stage III) correspond almost exactly with Erb's syphilitic spastic paraplegia, and the moderate cases of Lathyrism (Stage II) tally almost exactly with the ordinary spastic paraplegia.

Pathology.

15. Last year Erb delivered a lecture in London in which he traced our knowledge of disease of the spinal cord. He had predicted that the lesion to be found in the spinal cord in spastic paraplegia would be a degeneration of the crossed pyramidal tracts, and 20 years later a number of post-mortems were made which proved the truth of his surmise. The direct cerebellar tracts and the tracts of goll were also slightly affected. Only two cases of post-mortems have been recorded in cases of Lathyrism, and in neither of these has any microscopical examination of the spinal cord been made, but there can be little doubt that the lesion is the same as that which is found in spastic paraplegia.

Terms used by Natives.

16. Some of the expressions used by Natives in describing the symptoms may be mentioned for the benefit of those who are studying the disease in this country. Their term "jinjinny" is used to indicate the peculiar sensation which we call tingling, or pins and needles or which some have (probably not correctly) called formication. Their term "golee" meaning a ball indicates more exactly the nature of the affection than our word "cramp." Their term "nas-khenchna," meaning tightness of the tendons, is perhaps better than our term "rigidity," as it indicates the nature of the rigidity. Another common expression is "kamer-ki kamzori," meaning weakness at the waist. The clonic contractions in the legs they call "kapta-kapta."

CHAPTER III.—Theories of Causation and an Historical Review of Lathyrism in India.

17. If paralysis is caused by teora, it would seem at first sight that there ought not to be any difficulty in proving that teora is the cause. But it will be found that it is not an easy matter to bring forward clear and convincing proof. Many people eat teora and only a few are paralysed, and a large number of theories have been proposed with a view to explaining the peculiar incidence of the disease. The first step on the road to prevention must be the proving to the satisfaction of the people that teora is the cause. The course which I propose to follow is to give briefly the principal theories which have been advanced ; second, to explain the peculiar circumstances which have given scope for the introduction of so many theories ; third, to point out that there are two essential conditions under which the lathyrus must be eaten in order to cause paralysis ; and fourth to give an outline of the argument which will be brought forward to prove that lathyrus, when eaten under these conditions, will cause paralysis.

Various theories.

18. A large number of natives attribute the disease to "*khrab hawa*" meaning "bad air" like our word malaria. Many, including some Europeans, think that the rains play an important part in the causation. A few of the other theories that have been advanced are given below :—

(1) The sun—Dr. MacIntyre, Surgeon to the Artillery Division, Mooltan (about 1857).

(2) Immunity of the Punjabi perhaps owing to his superior physique—Dr. C. M. Smith, a Civil Surgeon of Lahore (before 1860).

(3) In particular years a "*khrab hawa*" blows—Many natives.

(4) Disease in the vetch itself—First by Dr. Smith and afterwards by many others.

(5) The grain grown on a particular soil—Many natives.

(6) That it is only the grain that is grown in the rains as a first crop.

(7) That the immunity of some is due to the method of cooking—Several writers.

(8) That the immunity in some districts is due to there being two kinds of teora—one non-poisonous and the other poisonous.

Why there are so many theories.

19. There are many circumstances which render proof a matter of special difficulty in the case of teora :—

(*a*) The grain is grown in different ways—on rice land and on wheat land—and Lathyrism is rare in the rice areas ;

(*b*) The grain is cooked in different ways—as a dhal (when it is boiled) and as bread ; where it is used as dhal, paralysis is not found ;

(*c*) In some districts where the grain is largely grown paralysis is rare, and in other districts, where the grain is grown in comparatively small quantities, paralysis is common :

(*d*) In some parts of the country the husks (testa) are removed and in other the husks are not removed, and it happens that the paralysis is rare in the parts where the husks are removed ;

(*e*) There is great variation in the quantity that people eat ; when used as a dhal only one-fourth of the whole ration is taken ; when used for bread the meal is mixed with other meal in varying proportions ;

(*f*) The grain is found in mixture and the proportions of teora varies ; the variation is increased by sifting, and a great variation is produced by famine ;

(*g*) The disease usually occurs in the rains, hence some have considered the rains as *a* or *the* cause ;

(*h*) The male sex chiefly are affected ; hence some have attributed the disease to exposure ;

(*i*) The people in the hill areas eat more "mahua" and they suffer very little from Lathyrism ; hence mahua was supposed to act as a preventive.

Four common and two essential conditions.

20. After notes of some hundreds of cases had been examined it was found that there were four common conditions which had been fulfilled by those who were paralysed in the northern districts. The teora was eaten as bread, with husk, in large quantity (more than half of the whole ration), and for a long time (over 2 months). It was subsequently found that there were a few cases in the southern districts in which the bread and husk conditions had not been fulfilled and the essential conditions were reduced to two *viz.*, large quantity and long time. It was not at first clear why the disease occurred so frequently in the rains, but I found that there is a general custom among the people in the northern districts to issue teora to the farm labourers in July, August and September; and it takes two or three months to cause paralysis, it was at once clear why the disease should occur in September. In the next two paragraphs will be found an outline of the arguments that will be given in subsequent chapters to show that there is no doubt that teora is the cause.

Koch's canons modified.

21. Professor Koch laid down four canons which he said must be fulfilled before we can connect any particular germ with any particular disease in the relation of cause and effect, and in a corresponding way we might make conditions which should be fulfilled in regard to a grain before we can be certain that it is the cause of a particular disease. These may be briefly stated as follows :—

(1) The grain must have been eaten in every case in which this form of paralysis is found.

(2) The seed must be translated from culture to culture for several generations, and when eaten must cause the disease.

(2) It must be capable of causing the disease in a healthy animal.

(4) On removal of the cause the animal or person should recover, unless injury of an organic nature has been done to any particular part of the body.

Other proofs.

22. In addition to the cases which will be referred to as instances to show that the four canons laid down above have been well fulfilled, there are arguments which are based on many other circumstances. These might be classified as follows : —

(1) *From families.*—In many families the consumption of grain was stopped as soon as one or two members were affected and the remainder escaped ; in other families that continued eating the grain none escaped.

(2) *From villages.*—There are many isolated villages where teora was grown and in which several cases occurred, while in the surrounding villages little teora was grown and there were no cases.

(3) *From districts.*—In Sambalpur very little teora was grown and there were no cases ; in Nimar little was grown but much was imported and there are several cases.

(4) *From the class in life.*—The malguzar (landlord) class with rare exceptions escape: the better class of cultivator escaped, while the poor cultivator suffered: the labourer, who was hired for a term and who was generally paid in grain that was not solely teora, fared better than the casual labourer. There are exceptions among the landlord class, but in such exceptions there is a common factor, *viz.*, debt. Servants whose pay was Rs. 7 or more per month will not be found among the paralysed.

(5) *From the severity of the attack.*—The worst cases will be found among beggars, mild cases among the cultivators, and severe cases among the labourers. There are exceptions, for some of the worst cases will be found among the cultivators that are—to use a slang expression—"*broke.*"

(6) *From the quantity eaten* (*and the proportion might be included under this head*).—From a number of cases it is easy to pick out those who ate teora unadulterated, if they have continued eating it for some months.

Historical Review of Lathyrism in India.

Sleeman, Kirk and Irving.

23. Among early writers on the subject of Lathyrism three names stand out prominently, and no account of Lathyrism would be complete without a reference to their observations. They are Major-General Sir W. H. Sleeman, Dr. Kinlock Kirk and Dr. Irving. Sleeman in his *Rambles and Recollections* describes an outbreak at Saugor in 1833:—

> In 1829, 1830 and 1831 the wheat and other spring crops failed. Teori, a kind of wild vetch, which though not sown by itself is left carelessly to grow among the wheat and other grain, and given in the green and dry state to cattle, remained uninjured and thrived with great luxuriance. In 1831 they reaped a rich crop of it from the blighted wheat fields, and subsisted upon its grain during that and the following years, giving the stalks and leaves only to their cattle. In 1833 the sad effects of this food began to manifest themselves. The younger part of the population of this and surrounding villages, from the age of thirty downwards, began to be deprived of the use of their limbs below the waist by paralytic strokes—in all cases sudden, but some more severe than others. About half of this village, of both sexes, became affected during the year 1833-34, and many of them have lost the use of their lower limbs entirely and are unable to move.

24. Kinloch Kirk gave a description of the epidemic in Upper Scinde. He saw it first in Shikarpur in 1845. His paper which was published in the *Annals of Indian Medical Science*, Volume VI, paragraphs 144—152, deals especially with husks of the dhals, and he was inclined to believe that the husks of the several dhals are injurious; he thought that when the skins of kesari* are not separated it becomes a slow but certain poison. In regard to kesari he made a point of questioning the sufferer in each case, and he says that without exception they admitted that kesari was the cause of the paralysis.

25. Coming now to Irving's writings, which were published in Volumes VI, VII and XXIII of the *Annals of Indian Medical Science* in the years 1860, 1861 and 1868, we find the subject of kesari dhal poisoning dealt with in an elaborate way. Irving had an exceptional opportunity of studying the disease, and his writings stand out prominently among the literature of that time. They are remarkable for their completeness and for their accuracy as far as one can now judge of their accuracy. Irving's papers are four in number. The first deals with the outbreak at Barra (Allahabad District), where 2,221 cases were found in 1857; his second paper deals with 889 cases that were found at Khyragarh in 1861; in the third paper is an account of 857 cases that occurred in an outbreak at Mirzapore in 1861; the fourth paper came to me as a great surprise some time after I had commenced this enquiry. It is the record of

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* In the northern parts of India the grain is called Kesari.

an enquiry that was made in 1864 by Irving in the North-Western Provinces. At Dr. Irving's suggestion the Secretary of the Board of Revenue issued a circular to all the districts in the Provinces, and with it sent a number of questions that had been drawn up by Irving. Replies were received from 37 districts, and a number of these replies have been put in tabular form by Irving. This paper is not of the same value as Irving's other papers. It is largely a collection of opinions received from the officers in charge of districts, but written mainly by native officials. Irving brought forward many arguments to prove that kesari was the cause.

Lathyrism in Allahabad after 1864.

26. The Reports printed in Volumes VI, VII and XXIII of *Indian Medical Science* trace the history of Lathyrism at Allahabad up to about 1864, the year when an enquiry was made in the North-Western Provinces. I am indebted to Mr. Harrison, Collector of Allahabad, for putting at my disposal his office file, which shows that the question of the causation of the disease attracted a great deal of attention between the years 1869 and 1874. In May 1870 the Government considered that Irving's view as to the relation between the disease and the consumption of the kesari was sufficiently probable to justify a prohibition of the cultivation. Mr. Robertson and Mr. Carpenter, Officiating Magistrates, Allahabad, strongly maintained that the disease was not due to kesari, and on the 4th August 1874 the order regarding the prohibition of the cultivation was withdrawn. The arguments which were brought forward to show that kesari was not the cause are briefly—

(*a*) the portions of males to females attacked is so great (2,901 males to 236 females, 219 male children to 33 female children);

(*b*) the fact that so many were affected in the month of *Bhadon* (September and October) seemed to indicate that the rains were the cause;

(*c*) the consumption of the grain, it was said, is commenced as soon as it is cut, and if kesari caused the paralysis the cases should occur in April, May and June.

As regards the first of these we now know that females very rarely suffer from spastic paraplegia. As regards the second Mr. Harrison has informed me that it is customary in the Allahabad Districts to issue more teora in the rains; and as regards the third, we know that even if the consumption of kesari were commenced as soon as the grain is reaped, the paralysis would not occur when the people begin eating it, but only after an interval of two or three months.

Arguments taken from Mr. Robertson's and Mr. Carpenter's own letters.

27. It is a curious thing that there are some strong arguments in favour of the view that kesari is the cause of the disease in the writings of these two strong opponents of that view. For instance, one of them said that the palsy is unknown in the fertile taluka Chorassiel, where there is no "mar" (probably black cotton) land and consequently no kesari. Mr. Robertson in 1872 said that the decrease in kesari cultivation had been accompanied by a decrease in the number of cases, and Mr. Carpenter in 1873 reported that the area had fallen from 18,211 acres in 1277 (Fasli) to 365 in 1280, and that the total number affected in 1277 was 2,908, in the next year 451, and in the next year only 92—1277 would be about 1869, A. D.). Then Mr. Carpenter contrasts a highland and plain showing that in the plain 60 per cent. of the villages were affected, while only 30 per cent. of the villages on the higher lands were affected, and he attributes the prevalence of the disease in the plain to the spongy properties of the black "mar" soil of the plain, but he failed to notice the fact that it is on the black soil that kesari flourishes and that on the highlands it is not much grown. After I had found out that it was a custom among the cultivators in parts of the Central Provinces to issue teora to the labourers in the rains, I wrote to the Collector of Allahabad and asked if such a custom would account for the seasonal prevalence in Allahabad. Mr. Harrison in reply said that there are 96 villages in the southern part of the Meja Tahsil, in which the practice of payment in kesari, at the end of the rains, is prevalent, and that this is one of the places where the disease is most prevalent.

CHAPTER IV.—Some General Information about the Central Provinces.

Agricultural, geographical and the influence of famine.

28. Lathyrism is confined to certain areas in the Central Provinces, and in order that we may understand the reason for the immunity in some parts and the prevalence in others, it will be necessary to consider briefly the agricultural conditions of the province. The crops that are grown for food are divided into two groups—the kharif, which are grown in the rains, and the rabi, which are grown in the cold-weather. The principal rabi crop is wheat, and the principal kharif crops are in some districts rice, in some districts juari, and in some districts hill millets and juari. From an agricultural point of view the districts in the Central Provinces might be divided into four groups according as the principal crops are (*a*) wheat, (*b*) rice, (*c*) juari and (*d*) hill millets, juari, and wheat.

Five geographical divisions.

29. The Central Provinces may geographically be divided into five large areas, *viz.*—

(1) The Vindhyan Plateau, two districts—Saugor and Damoh.

(2) The Nerbudda Valley, four districts in this valley, *viz.*, from west to east—Nimar, Hoshangabad, Narsinghpur and Jubbulpore.

(3) The Satpura Range—Betul, Chhindwara, Seoni and Mandla.

(4) The Nagpur Plain—Wardha, Nagpur, Bhandara, Balaghat and Chanda.

(5) Chhattisgarh—Raipur, Bilaspur, and Sambalpur.

There are three large plains which are drained by three large rivers—the Nerbudda, the Wainganga (a tributary of the Godavery) and the Mahanadi, and two elevated areas—the Vindhyan Plateau and the Satpura Range. Lathyrism is prevalent in one of these plains—the Nerbudda Valley—and in one of the elevated areas—the Vindhyan Plateau. There are over 4,000 cases on the plateau and over 3,000 in the plain.

Geographical and agricultural divisions compared.

30. The cold-weather crops are largely grown in the Vindhyan Plateau and in the Nerbudda Valley. The following figures which have been calculated from tables that are given in Mr. Craddock's Famine Report, and partly from tables which Mr. Sly, Commissioner of Settlements, has kindly sent me, show the percentages to total cropped areas:—

	Vindhyan Plateau.	Nerbudda Valley.	Satpura Range.	Nagpur Valley.	Chhattisgarh.
Cold-weather crops ...	66	60	40	33	20
Wheat ...	31	39	22	12	9
Hill millets ...	8	10	23	...	3

In calculating the averages for the Nerbudda Valley the figures for Nimar have beem omitted, because the agricultural conditions in Nimar are quite different from those of the other three districts. In the five districts in which Lathyrism is prevalent, the wheat area is high—34, 29, 48, 35, 36 per cent. In Seoni the percentage is 33, and it was from Seoni that a small epidemic of

Lathyrism was reported in 1893. In none of the other 12 districts is the percentage over 20. It is clear then that Lathyrism is to be found chiefly in the wheat-growing districts. But in these wheat-growing districts there are juari or hill millet areas, and it will be shown that Lathyrism is prevalent mainly in the wheat-growing parts of the wheat-growing districts.

Effect of famine and scarcity.

31. Writing of the famine of 1899, Mr. Craddock says, "For the past five years there has been no rain in October, and the area under rabi crops was five million acres under the normal in 1899-1900." The area under kharif had increased from 10 to 11 millions, while the area under rabi had fallen from 8 to 3 millions. For the six years preceding the famine of 1899 the outturn of crops was far below the normal, but the deficiency was most marked in the Vindhyan Plateau and Nerbudda Valley :—

Vindhyan.	Nerbudda.	Satpura.	Nagpur.	Chhattisgarh.
46	62	74	69	79

So that for six years preceding 1899 the people in the areas where Lathyrism is prevalent were hard pressed by famine or scarcity.

Lathyrism not a necessary result of famine.

32. If famine alone produced Lathyrism we should expect cases in the Nagpur area, or in Balaghat where for the six years preceding 1899 the outturn of crops was only 54 per cent. of the normal, and in the year 1899 only 11 per cent. of the normal. Balaghat has, however, only a very small percentage of wheat—only 4 per cent. The crops in Nimar in 1899 were almost a total failure, the yield being only 16 per cent., yet only a few cases of Lathyrism occurred, and these from teora that was imported. The wheat area is only 3 per cent.

Relation between failure of wheat and Lathyrism.

33. Sleeman described the failure of wheat in successive years before the epidemic of 1833. The wheat crop was very bad in all the districts in which Lathyrism is now prevalent. It failed in Seoni before the epidemic of 1893, and it failed in Betul before the epidemic of 1877. It will be seen that failure of wheat and barley preceded the epidemic in Algeria in 1881, so there seems to be a close connection between failure of wheat and Lathyrism.

Area under Teora.

34. Mr. Sly has sent a statement showing the areas under teora in each district of the Central Provinces for the past 12 years. We should expect to find an increase in the teora area between 1893, the year when the epidemic began, and 1899, the year when it reached its climax; but we find that instead of an increase there was a marked decrease from 634 to 161 thousand acres. It might also be expected that the area under teora would be greater in the five districts in which Lathyrism is prevalent; but if we compare three districts in the north where Lathyrism is prevalent—Saugor, Damoh, and Jubbulpore—with three districts in the south where there are very few cases—Bhandara, Bilaspur and Raipur, we find that there were in 1894 370,000 acres in the latter, while there were only 7,000 acres in the former. The area under teora was 50 times greater in the districts which are practically free from Lathyrism than in the districts in which cases abound. But in 1899 the area in the three districts in the south had fallen to 36,000 while in the north it had increased to 13,000. The proportion had altered from one-fiftieth to one-third. The area in the south had fallen to one-tenth of what it had been, while the area in the north had increased to double.

Statement showing the area under Teora (Lakh) during the years 1890-91 *to* 1901-02.

District.	1890-91	1891-92	1892-93	1893-94	1894-95	1895-96	1896-97	1897-98	1898-99	1899-00	1900-01	1901-02	Remarks.
	The figures below indicate thousands of acres (over 500 is counted as a whole thousand.)												
Saugor ...	3	3	2	3	4	3	4	10	10	7	3	4	
Damoh ...	2	2	1	2	2	3	5	7	5	4	3	3	
Nimar ...	...	...	...	...	...	...	...	1	1	...	...	...	
Hoshangabad ...	23	24	24	23	26	18	20	16	21	18	15	21	
Narsinghpur ...	8	14	14	11	19	15	16	23	20	19	26	26	
Jubbulpore ...	2	1	2	2	1	1	1	2	2	2	2	2	
Betul ...	18	18	19	20	18	15	13	12	17	10	8	11	
Chhindwara ...	5	5	5	6	6	5	4	4	4	3	3	14	
Sconi ...	23	25	19	34	43	25	13	17	19	10	11	4	
Mandla ...	...	...	...	...	...	1	1	1	1	1	1	1	
Wardha ...	13	12	14	14	13	9	10	11	10	5	6	8	
Nagpur ...	42	44	46	56	55	40	37	41	45	33	32	40	
Bhandara ...	90	90	90	147	144	94	47	88	105	20	69	64	
Balaghat ...	37	44	49	57	58	47	12	27	36	4	22	20	
Chanda ...	39	39	42	38	48	36	24	31	37	9	17	18	
Bilaspur ...	49	72	86	94	106	48	20	29	41	12	50	27	
Raipur ...	91	78	126	127	120	83	47	61	69	4	38	21	
Sambalpur ...	...	...	...	...	...	...	...	...	...	...	...	...	
Total ...	444	471	534	634	662	443	274	381	443	161	300	284	

Value of the area figures.

35. It would at first sight seem that these figures gave support to the theory that the paralysis is not caused by teora; but it must be remembered that these figures show *areas* under cultivation for teora, not the *outturn* of teora, and when we consider the difference in the conditions under which this crop is grown in the north and south, it will be seen that the area affords a very imperfect indication of the outturn. In the south teora is grown on rice land, and when the October rains failed, teora could not be put down, or if put down, it would not grow; whereas in the wheat land in the north teora grew well and gave a good outturn. But apart from the difference in the outturn in the areas which are shown in the table, a large amount of teora was grown that would not be shown in this table at all. This will be referred to when discussing mixtures, but it may be said here, that it would be impossible for any system of land records to indicate even approximately what was the yield of teora in Saugor and Damoh in the year 1899.

36. In the next two chapters will be given an account of the observations which were made during my tour through the Central Provinces, taking first the wheat districts where Lathyrism is prevalent and afterwards the rice districts where Lathyrism is rare. A comparison will be made between the customs in the wheat and rice districts, and the arguments for and against the various theories will be considered.

CHAPTER V.—Observations in the Nerbudda Valley and Vindhyan Plateau.

37. In the months of March, April and May, I made a tour through the Nerbudda Valley and the Vindhyan Plateau and also through the rice districts, Bilaspur, Raipur and Bhandara. In the tour through the Nerbudda Valley and the Vindhyan Plateau the principal places visited were Piparia in Hoshangabad; Sehora in Jubbulpore; Singrampur, Jabeta, Nohta and Damoh town in Damoh; Garhakota, Saugor, Rehli, Deori and Titarpani in Saugor. The results of the enquiries that were made and the observations that were recorded will be summarised in this chapter.

The Census.

38. In accordance with orders which were issued by the Hon'ble the Chief Commissioner, a census of cases of Lathyrism had been taken in five districts, and the totals in these districts are given below. At several places I checked these figures and they were found to be, in the main, accurate:—

Name of district.	Males.	Females.	Children.	Total.
Hoshangabad	1,418	270	.....	1,688
Narsinghpur	902	138	233	1,273
Jubbulpore	.....	.....	.....	294
Damoh	1,339	135	320	1,794
Saugor	2,116	216	405	2,739
Total ...	5,775	759	958	7,786

Year of occurrence.

39. Some old-standing cases are to be found in nearly every district; a few cases occurred in 1893 and 1895, but the epidemic may be said to have begun to be serious in the year 1896. The following figures which are taken from the Census Reports show the numbers that have occurred in each year from 1896 to 1902 in Saugor and Damoh:—

	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Saugor	548	463	514	526	393	204	88
Damoh	189	250	233	467	312	273	50

The wind theory.

40. It is a remarkable thing that even in the places in which Lathyrism is most prevalent many people will be found who are firmly convinced that the disease is caused by the wind. In Hoshangabad people thought that the cold wind from the river Nerbudda was the cause. In Jubbulpore it was thought that the injurious wind blew along the valley of Bohriban. In Saugor it was said that a very cold wind blows along the eastern border.

Comparison of areas.

41. At each place which I visited a few villages were picked out in which there were no cases of Lathyrism or only a few, and a few other villages in which there were several cases. With the assistance of the Revenue Inspectors the areas under teora were taken from the land records, and these were entered

in the Revenue Inspector's maps. The number of cases of Lathyrism was entered in the map in red ink, and it was then at once apparent that there was a close relation between teora area and the number of cases of paralysis.

Dhondi and Khapurkhera.

42. In Hoshangabad an officer of the Indian Civil Service informed me that most of the cases are on the north side of the railway, and that the general belief among the people was that it is the wind from the river that causes the paralysis. Next day I picked out two villages, one, Dhondia, being 6 miles from the river and the other, Khapurkhera, being 5 miles from the river. In the former I found that no teora was grown and there were no cases of paralysis. In the latter I saw 25 cases, and at the same time I saw 30 bullocks attached to one post and treading out the teora grain from the stalks. It was in this village that I was able to solve the problem which had at first puzzled me a good deal, *viz.*, why is it that so many cases of paralysis occur in September and October? There are two Court of Wards estates in Khapurkhera and records are kept which show the kind and quantity of grain that is issued to labourers. In this village it has been customary for the past five years to issue half teora and half wheat or other grain to the labourers in the rains. It was not the labourers on these estates who were paralysed, though there was doubt about one man, and so it would appear that a ration of half teora and half of other grain is a fairly safe mixture. The evidence in favour of the view that teora causes paralysis may be considered under three heads. First, the evidence of those who ate the grain, and all who were paralysed admitted that they had eaten teora in large quantity and for a long time. Second, none were paralysed who had not eaten teora. But there is no class of evidence so convincing as the evidence of those who ate the grain in large quantity, but who on finding that they had some unusual sensation suspected the grain and left off eating it. One cultivator, Tola Ram, stated that he and his two sons ate teora in 1897, and again in larger quantity in 1901. While working they felt "pins and needles"; they left off eating the grain and in a month they were quite well.

The Bohriban Valley.

43. In the Bohriban Valley, which lies in the Sehora Tahsil of the Jubbulpore District, there are 200 cases in the villages in the valley, with a population of about 10,000, while on the plateau on the north-west side of this valley there are only 39 in a population of 5,000. The native officials and leading men of Sehora were strong advocates of the wind theory, and when it was pointed out that the cases were more numerous in the valley, where the wind would be less than on the highland, their reply was that this particular wind was a bad wind which lay in the valley and did not ascend to the higher ground. There happens to be one village, Mohania, on the higher ground in which there is more teora (29 acres) than in any village in the valley, and 12 of the 39 cases are to be found in this village. Very little teora is grown in any other village in the highland.

Semripati Village.

44. The advocates of the wind theory then pointed out that in Semripati, one of the villages in the plain, in which there are 19 cases, no teora is grown as shown by the figures in the land records. This was a point in favour of their theory, unless it could be shown that the men had gone to work in another village, or that teora had been purchased from another village. I went out especially to enquire into this point and I found that wheat and teora are grown together and the mixture is shown in the land records as wheat. The people informed me that in the famine year the wheat failed and the teora flourished.

East part of Saugor.

45. The Deputy Commissioner had informed me that the part of the district in which Lathyrism is most prevalent is a strip along the eastern border, "a very cold tract and subject to bitterly cold winds." Two areas were picked out near Garhakota. In one group of villages which lie along the Kopra river

there are 256 cases in a population of 6,000 odd, and in the other group with a population of 9,000 there are only 15 cases. The area under teora was 304 acres in the former area, while in the latter it was only 34 acres. The proportion of affected to the total population was 25 times as great in the Kopra area, and the teora area was 9 times as great as it was in the other area.

Deori and Etawa.

46. A comparison was made between two Revenue Circles, one in the west of Saugor (Etawa) and the other in the east (Deori), and it was found that in the former with a population of 22,000 there were only 5 cases, while in the latter with a population of 28,000 there were 770 cases. The proportion of people affected in Deori was 119 times greater than in Etawa. There are no meteorological observations to show that the wind in Deori is stronger or colder that it is in Etawa, but on examining a statement which had been prepared by the Superintendent of Land Records I found that in 1897-98 the teora area in Deori was 277 times greater than it was in Etawa.

Lathyrism and wheat areas.

47. It was found in every district in which there are large numbers of cases of Lathyrism that the cases are chiefly in those parts in which wheat is grown. Take, for example, the four tahsils of Saugor. In Khurai and Banda the wheat areas are 16 and 28 thousands, while in the other two tahsils, Saugor and Rehli, the wheat areas are 114 and 100 thousands. In the two former there are 37 and 38 cases, while in the two latter there are 813 and 1,676 cases. Or take a comparison that was made between two groups of villages in Narsinghpur, 5 on the north side of the railway, that is towards the river, and 5 on the south side of the railway towards the hills. I found on the river side 118 cases, and on the hill side only 33 : in the former 16 per mille of the total population and in the latter 6. The wheat area is 14 times greater on the river side and the teora area is 16 times greater. On the hill side the gram, rice and bajra are double, and the kodo and kutki are 5 times as much as they are on the river side. It was found in every district that the hill millet areas are almost free from Lathyrism. It is the wheat areas that are affected, for teora grows well on the black cotton soil, which is also the best land for wheat, and when the wheat crop failed in successive years the people gradually began to eat more teora. What has been said above is the general rule, but exception will be found, for labourers often go from the hill areas to work in the plains and being fed on teora return to their homes paralysed, or the people on the hills may buy teora from the villages in the plains.

Relation of Lathyrism to river areas.

48. I noticed that in Hoshangabad most cases were on the river side of the railway and the same held good in Narsinghpur. Riding along the river Kopra in Saugor I saw over 100 cases in one morning : in Deori where I saw 220 cases in one morning, most of the cases were from villages that lie along the banks of the River Budna. Mr. Smith, I. C. S., has sent me carefully prepared maps of the Revenue Inspector's Circles in the Saugor District, showing the number of cases in each village, the rivers, and some details regarding crops, and he writes : " It will be seen that your theory that Lathyrism is largely restricted to wheat-growing areas is strongly exemplified in the circles of Deori, Rahatgarh and Garhakota. It will be found that all those villages in which the percentage is high are situated along the banks of large rivers." The advocates of the river-wind theory may bring this forward as an argument in favour of their theory, but let them remember that it is in such areas that we find the black cotton soil.

Customs regarding Grain.

Mixtures.

49. A study of the customs of the people in regard to grain will enable us to understand why the paralysis most often occurs in the rains, and why, as was pointed out by the Commissioner of Jubbulpore, the paralysis sometimes

occurs in a year that is not marked by any special distress or crop failure. No one who has not seen samples can realise to what an extent different kinds of grain are mixed up together especially in some parts of the Vindhyan Plateau. At every place I visited, samples of grain were taken from the threshing floors or from shops and the number of grains in each sample were counted. In the Nerbudda Valley wheat and gram are grown together and the mixture is called "birra." In the Vindhyan Plateau teora is added to this mixture, but other grains are often found mixed with these. Take, for example, a sample which was taken from grain that had been brought for sale by a cultivator; it contained wheat 37, teora 171, gram 31, masur 33, peas 64, barley 2, and mud 9. Now it will be understood that where people eat mixtures of this kind and where the mixture that they eat one day is probably different from the mixture that they eat on the following day, it would be difficult to find any definite or exact evidence as to the quantity of teora that is required to cause paralysis. A mixture like the one given above is called "gajra" or in Narsinghpur "gattara," and it is these mixtures which are particularly dangerous, for many people who would not eat teora alone will eat these mixtures. They do not however count them, and the proportion of teora is often very considerable.

Siftings.

50. Where gram, teora, and wheat are grown together the mixed grains are sifted, and I saw on threshing floors this process going on. Samples were taken from what passed through the sieve and from what remained. The small grains of teora will pass through with the wheat, but very little gram passes through. Take, for example, samples found in Basahri, a village in Saugor. In what passed through there was 7 per cent. of teora, while in the residue there was 61 per cent. of teora, 26 of gram and 11 per cent. of wheat. The Deputy Commissioner of Saugor had drawn my attention to the large number of cases of paralysis in this village, and he said that the people in such a village ought to have formulated some theory as to the cause of the disease. There are 33 cases in the village, and out of a total of 51 labourers, there are 24 paralysed, and most of them are bad cases. The malguzar sells the wheat and issues the siftings to the labourers; year after year for the past 7 years some have been added to the number already paralysed, and those who are already paralysed are becoming more and more hopeless cases.

Payment of wages in grain.

51. Farm labourers are of two kinds; the labourers who are hired for a term (*halwa*) and those who work for a daily wage (*naukar*). Both are paid in grain, as a rule, but there is more in the nature of a definite agreement as to the amount and kind of grain in the case of the former. For example, in Narsinghpur one malguzar gives 4 maunds wheat, 4 maunds teora, 4 maunds peas, and 4 maunds juari or gram. Another gives 2 maunds wheat, 6 maunds gram, 4 maunds teora, and 4 maunds rice or juari. (A maund is equal to 82 lbs.) In the famine years more teora was issued. To the day-labourer a larger proportion of teora was sometimes given, and it is among the day-labourers that the worst cases of Lathyrism are found.

Seasonal prevalence of Lathyrism.

52. Most cases of Lathyrism occur in the months of July, August, September, and October, and as these months are the rainy months, it was natural that the rains should be considered a factor in the causation, and there are some who consider that the rains are an essential factor, and who think that a man may eat teora for a long time in safety provided that he protects himself from the rain. There can be no more pernicious or dangerous theory. It is true that we frequently hear of men ploughing in the rains and of their having to be brought home in a cart, but let us consider what are the customs of the people, and for the present take it for granted that a diet of teora for two to three months will cause paralysis. In the months of April and May the people in the "rabi" country are engaged cleaning and winnowing their grain and the labourers are paid in wheat

and gram with, perhaps, a little teora. At the beginning of June the cleaned grain is stored in "bandas" or bins, and the cheapest grain is left out for payment of the labourers. This custom is universal in the Nerbudda Valley and in the Vindhyan Plateau. Teora is issued chiefly in the rains, and if the issue is begun in June, allowing three months as the required time, we should expect the paralysis to occur in August or September. The teora harvest is in March and where people were hard pressed as in Jabera in the Damoh District, where the wheat failure was marked, they began to eat it earlier, and we find in Jabera that some cases did occur in June and before the rains began. Of 42 cases that I saw there 25 had occurred in July, whereas of 124 cases reported by Hospital Assistant Ahmedud Khan from Rehli in Saugor, 59 occurred in October, 25 in September, 14 in August, and 13 in July. The time of the year when cases occur varies with the time when people begin to eat teora in large quantity. Numerous exceptions were found to the rule that the pa alysis occurs in the rains, but such exceptions always added more conclusive proof that teora is the cause of the paralysis, for it would be found that the persons affected had, for some reason, eaten teora in the cold weather or in the early spring. In September rain may fall on 20 days in the month and the chances are in favour of a man getting a wetting a day or two before the onset of paralysis. But even if the rain is an important factor in the causation, a cultivator cannot hope to escape from getting wet in this country in September. There are some strong advocates of the rains theory of causation, and this must be my excuse for referring to the matter again, but other evidence against that theory will be brought forward when we are considering the questions of sex, age, condition of life; and irrefutable evidence will be afforded by the cases that occurred in Nimar.

Advances made in grain.

53. Many of the cultivators are dependant on the malguzars for seed-grain, and the grain issued by some malguzars consists largely of teora. In the Deori plain, in the villages along the Budna river, I did not see any pure wheat, and all samples contained a large proportion of teora. As the teora is very prolific (I have counted as many as 145 seeds on one plant) there is a tendency for the proportion of teora to increase year by year. The advance referred to is called "kist," but there is another kind of advance which deserves notice. It is called "kawai" and is an advance made by shop-keepers to cultivators for food. I noticed this specially in Hinoti, a village in Damoh District, where there are 18 cases of paralysis in a population of 237, and where the crops are largely rice, kodo and kutki. It seemed strange that in such a village paralysis should be prevalent, but I found that advances are made in teora while the cultivators return wheat or rice. For instance, in one family in which this practice has been going on there are 6 brothers and 3 of them have been already paralysed. The "gajra" had 90 per cent. of teora.

Cases that were supposed not to have eaten teora.

54. In every district cases of paralysis were produced or reported in which the cause of the paralysis was said not to have been teora. For instance, at Gadarwara in Narsinghpur the Revenue Inspector reported 138 cases in which teora had been the cause of the paralysis and 39 cases which he said had not become lame from eating teora. I saw several of the 39 and they said that they had not eaten teora. When asked if they had eaten "gajra," they all admitted that they had. Similarly, cases were reported from Jubbulpore: they also affirmed that they had never eaten teora, but they at once admitted that they had eaten "gajra." Mr. Smith, I. C. S., Saugor, gave me the names of four cases in Deori in which the patients had denied that they had eaten teora. I saw three of them and examined the grain in their villages. Even now the mixture contains a large proportion of teora, and one of them, on being asked what his wheat was like in the famine time, remarked that it was all *chaff*. They admitted that they had eaten "gajra" in the famine time. A Deputy Inspector of Schools in Saugor reported a number of cases. They had never eaten teora he said, excepting the little quantities that are occasionally found mixed with wheat and gram. It is these "little quantities" that make the problems of Lathyrism much more complex than they may seem to be at first sight, for these "little quantities" may form 90 per cent. of the whole.

Sex, Age and Class in Life.

Sex.

55. Males suffered more than females and in every district and in almost every part of each district the proportion between males and females is almost constant—about 10 males to 1 female. To illustrate this we may take the figures from the Census of Saugor and Damoh, and to show how these figures correspond with those of the Allahabad epidemic, the latter figures will also be given :—

	Males.	Females.	Children.
	No.	No.	No.
Saugor	2,350	214	173
Damoh	1,339	135	320
Allahabad	2.901	236	252

The figures for each of the Circles in Damoh show the same proportion :—

	No.	No.	No.	No.	No.	No.
Males	88	220	332	119	192	388
Females	7	23	34	13	22	37

Or if we take the numbers in each ten-year period we find in nearly every period the same proportion. The following figures are taken from the Saugor Census :—

	10 to 20.	20 to 30.	30 to 40.	41 to 50.	51 to 60.	Above 60.
	No.	No.	No.	No.	No.	No.
Maies	631	927	504	230	51	7
Females	43	90	49	22	8	2

Among children we find that the boys are more often affected than girls. For example, in Damoh, 274 boys to 46 girls, that is about 6 to 1, and it is a curious thing that in the Allahabad epidemic 219 male children were affected and 33 female children, giving also a proportion of about 6 to 1. The girls suffer much less than the boys, and while the boys often require sticks, it is extremely rare to find a girl who requires a stick. The advocates of the exposure theory will have some difficulty in explaining why boys suffer so much more than girls, for even if it be admitted that the adult males of the working classes are more exposed than the females, it cannot be said that the male children are six times as much exposed as the female children.

Age.

56. If we divide the cases into groups by 10-year periods, we find that the largest number will be in the 21-to-30 age period, and it is a curious thing that the totals of the 11-to-20 and the 31-to-40 age periods are often nearly equal to the numbers in the 21-to-30 age period. The figures for Saugor have been given in the preceding paragraph, and the figures for Jubbulpore are 60, 117, 38, 26, 3, for each of the 10-year periods from 10 to 60.

Orphan boys.

57. While discussing with a number of the leading men of the Deori plain as to the cause of Lathyrism, a party of cripples were coming up for inspection, and at a distance of about 50 yards I pointed out one small boy, saying, "I have never seen him before, but you will find that his father is dead." On enquiry

they found his father had been dead for six years. His toes were in a position of extreme *talipes equinus* (the foot almost in a straight line with the leg), and one foot wriggled past the other with great difficulty. I had seen similar cases in other districts, and I knew that such extreme cases are only produced after very long continued consumption of teora. I asked them whether they could explain by their wind theory why the wind should pick out an orphan boy and convert him into such a contorted cripple.

Class in life.

58. Among those who suffer from Lathyrism there are a few beggars, an occasional artisan, and a few malguzars (landlords), but the majority were cultivators or labourers, and I noticed that in nearly every place the proportion of labourers to cultivators was about 3 to 1. For example, in Pachlawara (in Hoshangabad) 75 to 20, in Gadarwara (Narsinghpur) 26 to 9, Bohriban (in Jubbulpore) 27 to 8, Deori (in Saugor) 152 to 48. In cases seen at Garhakota the proportion was higher, 114, to 22. In Damoh I found some exceptions to this rule; for example, at Singrampur 11 to 12, and at Jabera 14 to 40, but many of the 40 had been cultivators and are now only labourers. But the incidence of the attacks among the labourers is greater than what is indicated by the figures given above, because the cultivators are more numerous than the labourers as is shown in Mr. Craddock's Famine Report (1899). The number of labourers to every 100 of the cultivators is 80 in Hoshangabad, 76 in Narsinghpur, 66 in Jubbulpore, 50 in Damoh, and 78 in Saugor. The incidence among labourers as compared with cultivators is therefore more nearly 4 to 1 than 3 to 1. Those who say that exposure to the rains is a leading factor in the causation may say that the labourers are more exposed than the cultivators, but the more simple explanation of the greater liability of the labourer is the fact that he receives the grain as a wage. Cultivators who are affected are almost, without exception, more or less in debt, and the few malguzars, who are affected, are probably without exception, in debt. Teora is a grain that people do not eat if they can afford to buy better grain, so that the incidence among these classes affords one of the strongest arguments that this cheap grain and not exposure to the rains is the cause of the disease.

Influence of poverty and debt.

59. It has been already shown that the advances which are made for seed or for food, and which often contain a large amount of teora, tend to increase Lathyrism. It has also been shown that the poorer class of cultivators are more subject to Lathyrism, but perhaps the influence of poverty and debt may be best illustrated by what I found in Talwa, a village in the Jubbulpore District, in which there are 15 paralysed in a population of 180, while there are only 3 cases in the surrounding villages. The proportion affected in this village was 80 times greater than the surrounding villages, and my attention was drawn to it specially because a large proportion of those affected are cultivators. It appears that the village belongs to a wealthy Native gentleman, that every cultivator is deeply indebted, that the landlord supplied them with "gajra" for seed, that he takes the wheat and leaves the teora for them, and that every year a paper is produced on which they make their mark, indicating that their debt has increased by the amount entered in the paper. I saw the landlord's agent and asked what he thought was the cause of the paralysis in this village, and he replied that it might be due to the tank. I pointed out that there are tanks at many other villages and that there were no cases in these villages. He then suggestsd that these tanks were not so deep, and I advised him in his own interest to stop the issue of teora for seed or he would soon have no one to cultivate the land.

A teora-stricken family.

60. The effect of poverty in causing Lathyrism in families may be illustrated by a family that I saw in Jabera in Damoh. The father and mother were employed on the famine works in 1899 and they received payment in cash. They bought teora in the Bazar and the results show that in famine times it would be

well to make provision for the supply of good food-grains in the bazar when cash payments are made. There are four members in the family—father, son, mother and daughter. They began to eat teora in April, and the father was paralysed in June before the onset of the rains, showing that the rains are not a necessary factor. The boy next became ill, then a month later the mother, and last of all the daughter, so that we have a good illustration of the incidence of the disease as regards sex and age. The man is in Stage IV, the boy in Stage IV½, the mother in Stage V, and the girl in Stage VI, so that they illustrate the severity of the disease at different ages and in different sexes.

Condition of those who are affected.

61. The Damoh Census shows the numbers in Stages IV, IV½, V, and VI as follows :—186, 101, 713, 794 ; and the proportion in these figures tallied in the main with what I saw, but I found the largest number in Stage V requiring one stick. It was found that those who require two sticks had eaten teora pure or almost pure for a long time. At Jabera, where I saw eleven men who had passed through Stage III, I made special enquiries about their condition. They had passed stools or urine in their clothes ; they had cramps in the thighs or calves ; all had "pins and needles" except one man ; all were laid up for some time—a fortnight, a month or more, and then they improved, and the bladder and rectal trouble ceased. I had already frequently heard that a man who gets into Stage III is often deserted by his wife, and at Jabera, in one day, 7 men informed me that their wives had left them. It will be seen that the wives in Algeria are not more faithful.

Suggested means of prevention.

62. Various suggestions had been made in regard to the methods which should be adopted for the purpose of checking the spread of Lathyrism. The prohibition of the cultivation was recommended, and the opinions in regard to this will be discussed in the chapter on prevention. In Damoh the people were advised to roast the teora before making it into bread, as it was supposed that the grain contained a volatile poisonous principle. The idea of roasting had been taken from Raipur, where although in past years there has been much teora, there have been very few cases of Lathyrism. In a report which was sent from Raipur it was said that the people roasted the teora before eating it, but it was also stated in the report that they also added a double-handful of rice. The Damoh people were not advised to add the double-handful of rice. They roasted the teora for a time, but soon stopped, as they said it spoiled the taste of the bread.

Mahua as a preventive.

63. In Saugor one Deputy Commissioner had noticed that there were many cases of paralysis in the Deori plain and few in the adjoining hills of Bharrai. He said, "not a single case of Lathyrism was seen by me among the forest villages where mahua is always eaten, although a few miles off, in the open country, the paralytics abound" ; and he suggested that the people of the labouring classes should be allowed to collect the mahua free of charge. I have not been able to find out the total quantity of mahua available in the Bharrai hills, but the Revenue Inspector thinks it would be about 600 maunds, and this if divided among the 22,000 people of Deori would give about 2 lbs. per man. A comparison was made between a group of villages which lie along the Budna river in the Deori plain and the villages on the Bharrai hills, and the principal points noticed were that there were 340 cases in a population of 6,479 in the Budna area, while there were only 16 cases in a population of 607 in the hill group. Most of the hill men who suffered had, however, gone down to work in the plain and had received teora as a wage. On comparing the teora areas in the two groups, it was found that the area under teora in the plain was 377 acres while there was only 1 acre on the hills. A more minute comparison was made between the crops in the two areas, 4 villages being at random in each. In the plain group the proportion of rabi (winter crops) to kharif (rain crops) was 3 to 1, while in the hill group the rabi was only one-eleventh part of the kharif.

The people in the kharif areas plough their land, sow their seed, and do their weeding in the rains, and are far more exposed to the rains than the people in the rabi areas, who although they do some ploughing in the rains, do most of their field work after the rains are over. Still we find that it is the people in the rabi areas that suffer most.

Cases in Nimar.

64. In districts where teora is grown and where it has been consumed regularly for many years, it is difficult to get valuable evidence in regard to the quantity of teora that is required to cause paralysis, or the time during which it must be eaten ; but in Nimar, although there are not more than 50 cases, there are some which are of exceptional value. The area under cold-weather crops in Nimar is very small and teora is only grown in very small quantity. In 1899 the crops, which are chiefly kharif, failed almost entirely, the yield being only 16 per cent. of the normal. Teora was imported and was eaten under almost experimental conditions in three families, so that we can get more accurate information in regard to time and quantity than we should be likely to find in other districts.

Nathu's family.

65. The first case I saw in Nimar was a man called Nathu, who lives in a village 12 miles from Khandwa. He stayed for four months in the hospital at Khandwa, and as I saw him almost daily I was able to study his case specially. After he left hospital I went out to his village and saw the other members of his family. There are three households. Nana is the head man. Onkar is his brother, and Nathu is the son-in-law of Nana. In these three households there are 21 persons, and of these 5 were more or less paralysed. The names and ages of those that were affected and those that escaped are given below :—

Affected.	Not affected.
(1) Nathu, age 30. (2) Nana 52, Lalu 22, girl 10. (3) Onkar 50.	His wife 22, girl 5, boy 4. Bhikia 25, Madho 12. Sukhi 6, Narain 5. and one girl. 3 men, 3 women and 2 girls.

In 1900 during January, February and March, they ate teora and little else. Occasionally they might get a little juari or mahua, but their chief ration was teora. The all ate it in the form of bread and with the husk. Nathu had at first informed me that Onkar had not eaten it with the husk, and it was chiefly for the purpose of enquiring into this point that I went to the village. I found that Onkar had sometimes eaten the husk, but it may be noted that he suffered only slightly, and he was the only one out of 9 in his house who was affected. If they could afford to remove the husk often they would probably not be so hard pressed as those in the other two houses. Nathu was the first to get ill, and his case was by far the most severe, as he got into the third stage and has been using two sticks. His wife had recently had a child and they thought it would not be advisable to give teora to her, so she was fed chiefly on juari. Had she known that she could eat teora with much less risk of becoming paralysed than her husband, she would probably have eaten the teora and have given the juari to him. Nana was the next to become ill ; he began to get cramps about 10 or 15 days after Nathu. Then Lalu got cramps, and shortly after him Onkar of the third house. The little girl was the last to become lame. She is only very slightly affected and does not require to use a stick. She can run a little, and she was able to walk 12 miles to Khandwa. She has a peculiar jerky gait, but if it were not that she belongs to a "teora family" it would be scarcely possible to diagnose her case. She was liable to trip and fall when attempting to run.

66. In Nathu's family the five persons were paralysed in the order given here—

Nathu age 30, Nana 52, Lalu 22, Onkar 50, girl 10. Nathu was the first, and as soon as he became paralysed the others suspected that teora was the cause. Nana had already been getting cramps and "jinjiny" : he stopped eating teora,

but paralysis came on after he had stopped eating it. The same thing happened in the cases of Lalu and Onkar. They are, however, suffering to a much less extent than Nathu. It is fairly clear then that it is not safe to go on eating teora until cramps are felt.

67. They ate teora in January and February and were paralysed in March, thus showing in a very definite way that the rains are not the cause of the paralysis. Sexual power was lost in the three married men; in the old men it has never retured properly but in the young man it has returned. They say they ate both kinds of teora and they think that the small teora is more injurious; but this evidence, it will be shown, is of no value, for the large and small teora probably come of the same plant. Nathu passed through Stage III and now uses two sticks; the two old men use one stick, and Lalu also uses one stick, but is slightly worse than the two old men. The boy has the teora toe nail (the inner side of the great toe nail worn away) well marked. It is very exceptional to find little girls affected, and when they are affected they suffer very slighty and do not require to use a stick. Nathu is shown in the photograph which shows 8 cases, and his foot-prints are seen on the right in the photograph which shows the foot-prints. I made enquiries from a large number of the other residents in Barud and found that although some hundreds of them ate teora they ate it mixed with other grains or with mahua.

The three well-diggers.

68. Three men were employed digging a well during the hot weather of 1899 by the Patel of Palsudh, a village in the Khandwa Tahsil. The names and ages are Kashi Ram 28, Munshi 18, Bhao 35. All three were paralysed and they have been treated in the Khandwa Hospital; the two latter are shown in the photograph Nos. 4 and 3 counting from the left. They received as wages three parts teora and one part gram; the two latter also received 2 annas a day and Kashi Ram, who was a professional well-digger, received 8 annas. Kashi Ram varied his diet with articles which he purchased from the bazar, and he suffered only very slightly, although he was at the age when men are usually attacked most severely. They began digging the well in March and they were paralysed in the hot weather and before the onset of the rains. They say that they ate teora for about two months. Munshi, a boy of 18 now (he would have been about 16 then), was not as ill as Bhao. Bhao had to use two sticks and later on used one stick, but rested the two hands on it (see photograph). Munshi never required to use the two sticks. The exact time during which they ate the teora could not be found out; one of them said a month, the other a month and 15 days, and again he said that it might have been two months, but the paralysis appears to have come on rather quickly in their cases. It is worth while noting that they ate the teora with gram, and it will be seen under pulses that both these are nitrogenous foods, and in order to satisfy the demand for carbo-hydrates, they would require to eat a larger amount of these grains than would be necessary to supply the required amount of nitrogenous or proteid material. The gram and teora combination is then probably a bad one.

69. Here then we have three men fed on teora under almost experimental conditions. If we wished to make an experiment on human beings to show whether the grain is poisonous in the hot-weather, or to show whether a boy of 16 is as much affected as a man of 33, or to show whether a man eating a large quantity is more likely to be more affected than a man who eats a small quantity, the conditions of the experiment would not differ very much from those under which these unfortunate men were placed by the patel of this village. We should require a control or check experiment; that is, we should put other men under similar conditions with the exception of the consumption of teora, but even this check or control we have in their case for they had been digging wells frequently before. Kashi Ram and Bhao were men of about the same age; the former ate a comparatively small amount and the latter ate a large amount; while the former suffered only slightly and can now walk without a stick, the latter used two sticks for some time and now can only get along by resting the two hands on one stick.

The Killodh family.

70. While out in camp in North Nimar, 30 cases were brought to my camp at Singaji. Detailed notes of all these cases were taken, but there is one family of special interest, because here again the conditions were almost those of a scientific experiment. There are 15 persons in the family and of these 5 have been paralysed. The head of the house had gone to Harda in Hoshangabad and bought one "mani," which in this part of the country is about 12 maunds or 960 lbs., and for this he paid Rs. 35. Teora was selling then for about 12 or 13 seers per rupee, so the quantity stated by him is probably correct. Harda is 30 miles from Killodh, so the purchase of such a large quantity and at such a distant town is a circumstance that would probably impress itself on his memory.

71. There are 15 people in the family, but of these two have been born since. Of the 13 who were in this house in 1899 five have been paralysed—three males and two females—an unusually large proportion of females; another curious thing it that the females were paralysed first. The names and ages of all are given below, and the names of those who are paralysed are shown in italics:—

Males.	Years.	Females.	Years.
Mohan	... 50	Panchi	... 45
Lachia	... 30	Dipa	... 26
Onkar	... 28	*Rukhmi*	... 22
Sukdeo	... 30	*Ganga*	... 24
Mukunda	... 22	Mohani	... 22
Harchand	... 18	Rupa	... 4
Bhondria	... 14	Sukhi	... 1½
		Jabu	... 1½

72. Enquiries were made in regard to several points, as—

(*a*) *Quantity eaten daily.*—They had told me that they took two-thirds teora and one-third wheat or any other grain. A few months later the Superintendent of Vaccination went specially to the village to enquire about the cases, and their statement to him tallied with the statement made to me. If that may be taken as correct, it shows that the teora, even if mixed with other grain, will cause paralysis.

(*b*) *In what season did the paralysis occur?*—The teora was bought in January and they began eating it in that month. They were paralysed in April—Rukmi first, Ganga a week later, and at intervals of a few days, or a week, Sukdeo, Onkar and Bhondria. If we take the quantity that was bought as 960 lbs., and if 13 people were eating on an average a pound a day, this quantity would last for 73 days, so their statement as regards time and season is probably fairly correct.

CHAPTER VI.—The Rice Districts.

73. There are 6 districts in which a large amount of rice is grown, *viz.*, Bilaspur, Raipur and Sambalpur in the Mahanadi area, and Bhandara, Balaghat and Chanda in the Waingunga area. The percentage of area under rice to the total cropped area is 50 in these districts, while in the other 12 districts the average is only 6 per cent. Rice requires a large amount of water, and the average rainfall in the rice districts before 1892 was 54 inches, while in the other districts the average was only 46. In April I made a short tour through parts of Bilaspur, Raipur and Bhandara. In this chapter I shall make a comparison between the customs in the rice and wheat districts as regards agriculture, the payment of servants, and the methods of cooking; then discuss the theories that have been advanced in the rice districts and give the evidence which was obtained for and against the various theories.

Customs.

Agriculture.

74. Rice is grown in land that is divided into small plots and each plot is surrounded on the lower sides by a little embankment which retains the water. The rice is sown in July soon after the beginning of the rains, and in October the teora is sown broadcast a few weeks before the rice is ready for cutting and while it is still standing in water. If there is no water in the rice fields the teora cannot be sown, and so we find that in a year like 1899, when the late rains failed, only a very small amount of teora was sown. For instance, in Raipur the area which had been 127,000 in 1893 was only 4,000 in 1899. The area was only $\frac{1}{32}$nd part of what it had been, but it is probable that the outturn was even very much less. A comparatively small amount of teora is grown on wheat land, and in the country around Pownee in Bhandara, where a considerable amount of wheat is grown, a good deal of teora is also grown. It was at Pownee that Dr. Prentie saw a number of cases of Lathyrism which formed the subject of a report that he wrote in 1893, and he has sent me recently a note of 98 cases which he saw in the same part of the district. The teora that is grown in the rice land is called lakhori and that which is grown on the wheat land is called lakh.

Payment of servants.

75. In Bilaspur a labourer and his wife receive a fourth part (chouthia) of the crop. Kodo and rice are given as wages and occasionally a little wheat, but it is not customary to pay the servants in teora. The grains are not mixed in the same way as they are in the north, and I did not see or hear of any mixtures like the "gajra" of the northern districts. Dr. Prentie wrote in his report of 1893 that farm labourers received payment in this grain and were compelled to subsist on it for long periods. All classes used it occasionally, but only in addition to other food. The persons affected were entirely field labourers; and of the 98 cases which he reported recently, the majority were labourers and had been paid in lakh.

Method of cooking.

76. The teora is used in many ways: the flour may be mixed with country sugar and made into balls (ladoo); the whole seeds may be roasted and eaten in this form (chabina); the flour may be used for making a sweetmeat (seah), but the amount used in these ways is small. The three principal articles of food that are made from it are bread, dhal and porridge. Teora in the north is eaten almost entirely in the form of bread, but in the rice districts it is very rarely eaten in the form of bread, and the exceptions to this rule are to be found chiefly in Pownee in Bhandara. Teora is used largely as a dhal; the seed is crushed, and after removing the husk it is boiled in water or in rice water. When used in this way it is generally eaten with rice or with bread. When eaten as bread it may often constitute the whole ration, but when eaten as a dhal it forms only a very small proportion of the ration. I think I may say that millions of people have eaten the grain as a dhal, but after many enquiries I could not find or hear of any one who was paralysed from eating the dhal. By some the grain is eaten in the form of porridge called ghoto, the teora flour being put in boiling water and stirred.

Theories regarding the cause of immunity in the rice districts.

77. When Lathyrism became so prevalent in the northern districts, enquiries were made in the rice districts with a view to finding how it was that Lathyrism was so rare in the latter districts although such a large amount of teora was grown. A great amount of literature was the result and many theories were advanced. These may be referred to briefly under (*a*) roasting, (*b*) washing, (*c*) an ergot, (*d*) the husk, (*e*) two varieties of teora, and (*f*) first crop teora.

Roasting.—In one report that was sent from Raipur it was said that the teora is generally roasted before it is made into dhal, and it was stated that the people added a double handful of rice to each handful of dhal. The double handful of rice would reduce the quantity of teora below the proportion that is dangerous, so that there was no proof that the roasting removed the deleterious principle. But as far as I could find out it is not a general custom to roast the grain before making it into dhal.

Washing.—Lieutenant-Colonel Chatterji, I. M. S., thought that immunity was due to washing, and he said he never saw cases of Lathyrism in Bengal where people wash the dhal before cooking it. The quantity used, however, would only be small, and there is no evidence that a washing removes the poison from the grain.

An ergot.—This theory will be discussed in the chapter on the nature of the poison. The advocates of this theory have never attempted to bring forward any evidence to show that the teora which causes paralysis has anything in the nature of a fungus growing on it. Their evidence is all of a negative nature. Unable to account for the prevalence in some parts and the immunity in others, they are of opinion that there must be something in the nature of an ergot grown on the grain, but the quantity and time factors will account for the peculiar distribution of Lathyrism.

Husk.—The people in the rice districts remove the husks and the people in the northern districts as a rule do not. It was therefore thought that the poison might be in the husk. In the northern districts, although I enquired into this point especially at every place I visited, I could not find any exceptions to the rule that the husks are eaten, but at Mungeli in Bilaspur and at Drug in Raipur, I found a number of cases which, I think, put it beyond doubt that the poison is not in the husk or at least that it is not confined to the husk.

Cases seen at Mungeli.

78. At Mungeli I saw 21 cases which Dr. (Mrs.) Gordon had collected. The first cases examined were the family of Sutna (Teli). In a family of six all are suffering from Lathyrism except a child of 3. The teora which they ate was grown on rice land, and was similar to the sample shown to them (lakhori); they do not grow teora on wheat land and they did not buy any teora. Their rice crop failed owing to the failure of the early rains, but in September rain fell and they were able to sow teora. They ate the teora as bread, as dhal, and as porridge, but in whatever form the teora was eaten the husk was first removed. The woman remained outside while the man was being questioned; and when afterwards she was called in, she confirmed in every detail what the man had said. The case is a remarkably clear one; there can be no doubt that they are suffering from teora paralysis; they did not eat the husk, and the grain which they ate was the rice land teora which has been supposed to be non-poisonous. In another family the father, son and daughter are paralysed. They ate the small teora yellow and they did not eat the husk; the teora was grown on their own land and it was a rice land crop. Three other cases from the village Jhulna and two brothers from Jherragaon gave similar evidence.—They ate the teora chiefly in the form of porridge, and it is therefore probable that the amount of boiling to which the teora is subjected in the preparation of porridge is not sufficient to destroy the poison. Similar cases were seen at Drug in Raipur.

Question of two varieties or races.

79. In 1857 Kinloch Kirk asked the question "why do only a comparatively few suffer from Lathyrism" and "Why does one district suffer more than another where this food is extensively eaten?" and an enormous amount of

literature has been the result of endeavours to answer these questions. One of the oldest and even now one of the most favourite theories is that there are two different kinds of lathyrus. In 1857, Kinloch Kirk, quoting Roxburgh, supported the view that there are two varieties. The Honourable Mr. Fuller and Mr. Duthie had samples grown, and they found that plants grown from seeds of both kinds gave plants that were botanically identical. Lieutenant-Colonel Prain, Superintendent of the Botanic Gardens, Calcutta, after an exhaustive study of the leguminous plants of Bengal, came to the conclusion that botanically it was not possible to separate off two distinct varieties. Sir George Watt could discover no character by which the lakh and lakhori could be distinguished botanically, and he thought that there might be different "races." Mr. Sly, Commissioner of Agriculture, will only go so far as to say that there is an agricultural difference. The agricultural difference has been already explained, and perhaps the continued growth of rice land teora on rice land has produced a different race. At any rate it is easy as a rule to distinguish a heap of lakh from a heap of lakhori, but there might be a difficulty in distinguishing single grains of the two kinds. The wheat land teora or lakh is as a rule larger. I took 100 grains from specimens received from nearly every district in the Central Provinces and weighed them. The weights of the 100 grains of lakh varied between 245 and 110 grains, while the weights of lakhori varied between 108 and 77 grains. The colour of the wheat land teora is darker than the colour of the rice land teora. The latter is called the yellow latri in Azamgarh.

Is one kind poisonous.

80. In Azamgarh in the North-Western Provinces the people consider that the yellow latri is non-poisonous, and the people in Bhandara have for many years held the same opinion. I enquired into this point particularly and asked those who held this opinion if they could point to any man who had eaten the lakhori in large quantity and for a long time and they could not. The lakhori is eaten as a dhal, and in this form it is never eaten in large quantity. I could not find a trace of evidence in Bhandara to show that the lakhori if eaten under the conditions, which in the case of wheat land teora we know are essential, *viz.*, large quantity and long time, is non-poisonous. That it is poisonous has been shown by the cases which were found in Mungeli.

Relation of Lathyrism to Famine.

81. Bhandara is one of the districts in which there was acute distress in what is known as the Bundelkund famine in 1868-69. About 380 deaths were attributed to starvation and over 10,000 people emigrated. Rao Sahib Rung Rao, Manager of a large estate, states that he came to Bhandara in 1865; he remembers the famine of 1868; rice and wheat failed, but teora grew well; he saw several cases of paralysis in Pownee, and he asked several what was the cause; they all said it was lakh. Among the cases which have been reported by Dr. Prentie, there is one, a Gond, now 45 years of age, and living at Ajgaon, who was paralysed when he was 13 years of age, and at the same time several others were paralysed in his village. Among the cases which I saw at Pownee there was an old man of about 50 (Goma, a Dhimar), who said he was paralysed when he was about 12 years of age, and that in the same year 10 or 12 others were paralysed in his village. These cases probably occurred about the time of the Bundelkund famine. But there are many who were paralysed in more recent years, and it is probable that the custom of payment of wages in teora having been begun in the times of famine was continued for some years after the famine had passed.

Summary of evidence from the rice districts.

82. There is no proof that roasting or washing removes the poison. It is clear that the poison is not confined to the husk. There are two kinds of teora, but the idea that one is poisonous and the other not is not supported by any evidence. It is clear that the amount of boiling to which the grain is subjected in the preparation of porridge is not sufficient to destroy the poison.

In the next chapter the literature on Lathyrism in Algeria, France and Italy will be reviewed, and a comparison will be made between the epidemics in these countries and those in India.

CHAPTER VII.—Lathyrism in France, Italy and Algeria.

83. The best account of Lathyrism in France and of the use of lathyrus in France was written by Chevalier in 1841 under the title of "Gesse in bread." An outbreak which had occurred in *Loir et Cher* in 1829 had been investigated by Desperanches who was Physician-in-Chief of the Hospitals at Blois and a Member of the Royal Academy of Medicine. Chevalier gives in full a letter in which Desperanches described this outbreak, and the following are a few clauses which I have marked in this letter :—

"Cases occurred in more than eight villages. The first sufferers had no idea of the cause. The intensity of the disease was in direct proportion to the quantity of lathyrus flour which was added to the wheat flour. The people in La Chauses Saint Victor had used the grain for five years, but only began to experience ill-effects when they raised the proportion to one-half, due to the dearness of wheat. I have asked the Administration to stop the culture."

The Niort Law Suit.

84. Chevalier gives details of a law suit at Niort in which a farmer was sued for causing injury to one of his servants. He had fed his servants on bread made of barley, rye, and gesse mixed together. Five of them were crippled. To four he gave compensation and the fifth, to whom no compensation had been given, brought an action against him. The case was tried first in the Criminal Court and afterwards in the Civil Court. The farmer was ordered to pay a fine and a yearly compensation of 60 francs.

Lathyrism in Italy.

85. Cantain saw two cases at Naples in 1873, and it was he who first gave the name Lathyrism to the disease. Giorgieri saw two cases at the Royal University of Parma in 1881. Dr. Brunelli saw five cases in Rome. They had come from Alatri, a province of Rome, and he with his colleagues visited that province and saw six other cases. Brunelli has given a minute account of the disease in a paper which was published in the Transactions of the International Medical Congress, held in London in 1881 (Volume II, page 45).

Lathyrism in Algeria.

86. An epidemic occurred in Algeria in 1881 and the subject was then very fully investigated by many French Medical Officers. Dr. Proust was appointed by the French Government to enquire into the outbreak. He was accompanied by Professor Bourlier. M. Grandjean, Medecin Major, admitted 14 cases into hospital and observed them for a month. M. Pierre Marie wrote two papers which appeared in Le Progres Medical. I have received translations of the papers and reports which were written by these medical men. The symptoms as described by the French are the same as those observed in India, but it is rather a surprise to find how closely some of the customs in Algeria resemble those of India. The grain is used for making bread, but seldom alone : it is usually mixed with other grain and the proportion is generally less than half: the proportion runs up in times of scarcity: the cause of the increased proportion is failure of wheat and barley, for the lathyrus grows comparatively well in years of drought. The most remarkable point of similarity is the custom as regards siftings, for the siftings which contain much lathyrus and little wheat are put aside and sold to the poor.

Other points of resemblance.

87. There are long intervals between epidemics, but the old men remember a previous epidemic. All sorts of theories are advanced by the people to explain why the disease sometimes attacks them and why they sometimes escape—as eating flesh of black goats, sleeping near lathyrus straw, and so on. The price of the grain is about half the price of wheat.

The nature of poison.

88. Proust, Marie and others enquired into the nature of the poison and the general opinion was against the view that the disease was caused by anything in the nature of an ergot.

Time and quantity factors.

89. Several of the writers gave special attention to the questions of time and quantity. Several cases are mentioned of people who ate the grain, and who after experiencing the first symptoms stopped eating the grain and got well. The time required to produce paralysis is 6 weeks to 3 months, and when the proportion comes up to or exceeds half it is considered dangerous.

Agricultural.

90. The crop is much valued by the natives of Algeria. The straw is given to bullocks when employed at hard work. The people feared that the Government would stop the cultivation.

Seasonal prevalence.

91. The attacks usually begin in March and April. The grain is sown in March and is harvested in August, so that epidemics occur as in India about 6 months after the harvest.

CHAPTER VIII.—Lathyrus as a Food for Man and Animals.

The pulses in common use.

92. There are several different kinds of pulses that are used almost daily by large numbers of people in India. They are divided into three groups, *viz.*, those that are grown in the rains—mung, motth, urd, and chowlai ; those that are sown in the rains and reaped after the cold weather—arhar and tur ; and those that are grown in the cold weather—chenna, masur and teora. These pulses have been frequently analysed, and the most notable point of difference in their composition is that teora contains a much larger proportion of proteid material than any of the others. It has 31 per cent., while the others have only from 23 to 25 per cent. The pulses are best suited by their composition to replace animal food. They are used by natives in small quantity, about 4 or 6 ounces daily, with about 20 ounces of wheat, juari, or rice. "Experience," says Yeo, "has shown that the diet best suited for the body must contain one part of nitrogenous to 3½ or 4½ of the non-nitrogenous." The ordinary diet of the native would therefore be a good diet.

The nutrient ratio.

93. The proportion of albuminoids to starch, including with the starch the starch equivalent of any oil or fat present, has been called the nutrient ratio. The nutrient ratio in a good diet is 1 : 5. Of the 40 or 50 important grains or seeds only a few approach to the standard nutrient ration. Wheat comes nearest to a perfect diet. The nutrient ratios of a few grains are given in the following table, and it will be seen how far the lathyrus differs from a standard diet. Church's "Food-grains of India" gives much valuable information on this subject, and the reader is referred to his book for further information.—

Name.	Nutrient ratio.	Name.	Nutrient ratio.
Wheat ...	1 : 5·2	Pigeon pea (tur) ...	1 : 3
Rice ..	1 : 10·8	Peas ...	1 : 2·4
Maize ...	1 : 8·3	Soy bean ...	1 : 2
Chenna ...	1 : 3·3	Lathyrus ...	1 : 1·75

Waste of food.

94. We learn from Hutchinson's Book on Food and the Principles of Dietetics that it would require about 1⅓ pounds of pea flour to supply the amount of proteid required daily by an active man. This would not contain a sufficient amount of carbo-hydrate, and it would be very deficient in fat. It has been found that when the quantity of peas eaten amounts to 30 ounces in the 24 hours, all the demands of nutrition are satisfied. In taking a full diet of peas then there would be great waste of proteid material. The nutrient ratio of the pea is 1 : 2·4, but the nutrient ratio of the lathyrus is only 1 : 1·7, and therefore there would be much greater waste of proteid material when teora is used as a whole diet. The nutrient ratio of rice is 1 : 10·8, and if rice were used a whole diet there would be great waste of carbo-hydrate. In the Central Provinces, during the famine time, many people were eating a purely rice diet and many were eating a purely teora diet. A combination of these foods would have resulted in a saving of food on the whole.

Are the poisonous properties of teora due to its excess of nitrogenous material.

95. It has been suggested that the poisonous properties of teora are due to the consumption of such a large amount of nitrogenous material, and as we cannot find any other dhal which is used in such large quantity and for a long time by the people, there appears to be at first sight some grounds for this belief. But when we consider its effect on horses we find that when mixed

with other grains and not taken in very large quantity it causes paralysis in horses, so that we can, I think conclude that the poisonous influence is not dependant on the excess of nitrogenous material.

Safe proportion of teora.

96. Teora has been used for years in the Bhandara Jail as dhal, and also in the Balaghat Jail in the same way, the amount for each person being 4 or 6 ounces daily, and no bad results have followed its use. It has been used by enormous numbers of people in the famine times and in ordinary times for making bread, and it appears that it is only when the proportion exceeds one-half of the whole diet that paralysis results. And it is only when a large quantity has been consumed for a long time that it causes paralysis.

The husks.

97. In 1857 Kinloch Kirk expressed the opinion that the poison is in the husks, and in recent years many have expressed the same opinion. Natives generally remove the husks of all the dhals before cooking, except perhaps of chowlai and "motth," and in the rice districts the husk of the teora is also removed. It happens that the husk is not removed in the wheat-growing districts, where teora is consumed in large quantity. Hence there appeared to be some grounds for the supposition that the poison lies in the husk. In a paper read before the Society of Analysts (London) in 1895 by John Hughes, Esq., it was pointed out that the husk forms from 14 per cent. in large lathyrus seeds to 24 per cent. in small seeds. As the husk forms about one-fifth of the whole seed, people who are hard pressed for food often cannot afford to throw away the husk. That the poison does not lie entirely in the husk is clear from the history of the cases that were seen in Mungeli.

As a food for animals.

98. The Reports on the Royal Veterinary School at Alfort for 1820 and 1822 contain references to the effect of lathyrus on horses. A horse was shown to the students which while standing seemed to be quite well but after exercise roaring was clearly manifested. Professor Delaford of the Royal Veterinary School at Alfort described 3 cases among the horses of the Villineuve Diligence Company. The horses of this Company to the number of 25 were fed on lathyrus stalks and seeds beginning from the 15th April. Between the 15th and 20th June 3 horses during their trips were attacked with roaring and it was necessary to unharness them. The lathyrus was stopped and they recovered. In 1869 M. Verrier of Rouen addressed a report to the Central Society of Veterinary Medicine, in which he described an outbreak among the horses of the Rouen Omnibus Company. From October 1854 horses received lathyrus, the quantity varying from 1 to 2 litres in the day. In January some began to be ill. Nine died and 20 had to wear tubes after tracheotomy.

In 1894 the Bristol Tramway Company fed their horses on "Indian peas" which contained a large proportion of lathyrus. The horses began to be ill, but no one at first suspected that the "peas" were the cause of the trouble. Out of 127 horses that became ill 12 died and many were sold at prices as low as £4. The Company claimed £2,811 damages from the firm that supplied the feeding cake. The trial was reported in the *Mark Lane Express* of 30th July 1894.

In 1893 in Worcester some cattle and sheep were fed on feeding cake that contained a very small amount of lathyrus. Many of the animals died, and in a law suit which followed a verdict was given against the cake-makers. It is probable, however, that the evil effects in this case were not caused by lathyrus.

Discussions in England.

99. The Bristol and Worcester cases excited a good deal of attention in England, and in March 1894 J. A. Voelker, Esq., Ph. D., B. Sc. read a paper on the subject before the Society of Analysts. In 1895 J. Hughes, Esq., read a

paper before the same Society in which he went fully into the question of the method of distinguishing the starch and testa and lathyrus when mixed with meal from other seeds. The papers are printed in the "*Analyst*."

In the Central Provinces.

100. Before the years of scarcity teora was grown for feeding bullocks and it was usually given to them as green food. There is a large amount of evidence that when given as green food it is not only not injurious but that it is an excellent food. Of course it would only be given as a green food for about 6 weeks in the year, and there is nothing to show that if the green plants were given for a long period, injury would not result. The seeds are sometimes given to bullocks. There is a good deal of evidence, not amounting to proof, that the seeds cause paralysis in bullocks and buffaloes. It seems to be fairly well known that the seeds cause paralysis in horses.

CHAPTER IX.—The Nature of the Poison.

A poisonous family.

101. Lindley, after referring to many plants of the order *Leguminosæ* that are cultivated on account of the beauty of their flowers, to others that are cultivated for their wood, to the many species that are cultivated as staple articles of diet, says that it must be borne in mind that on the whole this order, in which there are 7,000 species, must be considered poisonous, and that those which are used for food by man or animals are exceptions to the general rule; in such cases the deleterious juices of the order are not sufficiently concentrated to prove injurious and are in fact replaced to a considerable extent by either starch or sugar. A number of plants in this order that are known to be poisonous are mentioned by Bentley, *e. g.*, the roots of the Scarlet Runner, the seeds of the Laburnum and Calabar bean, the seeds of *Abrus Precatorius** (which is used in India for cattle poisoning), and the seeds of *Ervum Ervilia* (the bitter vetch), the juice of *Coronilla varia*, the leaves of others and the bark of others.

The border-land.

102. Between such extremes as the common bean and the Calabar bean it might be expected that there would be many degrees of intensity of the poison, and it might also be expected that the line dividing what may be called poisonous from non-poisonous seeds would not be a hard-and-fast one. It might be expected that it would be a border land rather than a border line. If the poisonous principle of the lathyrus is in the lathyrus from the beginning, and is not the result of the growth of something in the nature of an ergot or the result of decomposition caused by some special kind of fungus, the lathyrus would be one of those plants that come in between those that are admitted by all to be poisonous and those that are admitted by all to be non-poisonous.

Phaseolus Lunatus.

103. Perhaps in *Phaselous Lunatus* may be found a seed that has many points of resemblance to lathyrus. In Watt's Dictionary a description of these seeds is given, and it is said that they are sometimes used as food, but that some of the species sometimes exhibit markedly poisonous properties. Dr. Prain informs me that a few years ago a horse-dealer in Calcutta told him that some of his horses had become paralysed from eating beans which had been imported from Coconada, and that although he had fed his horses on this bean before, he had not noticed any bad effects. Dr. Prain planted some seeds and found that they were the common Lima bean (*Phaseous Lunatus*). The truth is, adds Dr. Prain, the whole of the Leguminosæ, much as we use them, are a suspicious family.

Grain Poisoning.

104. Grain poisoning may be of three kinds. The poison may not be in the grain itself but in a growth that takes place on the grain—for example, the ergot of rye—or the poison may be the result of the action of a fungus on diseased grain as in the grain that causes Pellagra, or the poison may be in the grain itself as in *Lolium temulentum* (darnel). Many have advanced the view that the poison of lathyrus is the result of a fungoid growth, and therefore it will be well to consider briefly what is known in regard to the diseases here mentioned.

Ergotism.

105. The most severe form of grain poisoning was Ergotism, from which 10,000 persons died in the 10th century in Limousin, Aquitaine and neighbouring parts of France. In the 18th century Thullier discovered that the cause

* The poison of the *Abrus Precatorius* was studied by the late Professor Warden, I. M. S. It is used largely in India for cattle poisoning. The poison is put on "suis" (needles) and these are inserted under the skin. It causes a lethargic condition, staggering gait, and death. Warden obtained from the seeds two principles—a proteid having properties analogous to those of emulsion, and a leguminous matter like amygdalin. A temperature of 100° destroys the activity of the seeds, apparently by coagulating the proteid body, in the same way as boiling water when added to a mixture of emulsion and amygdalin prevents the formation of hydrocyanic acid by coagulating the emulsion.

lay in the spurred rye. Professor Kobert discovered two poisons in the ergot—sphacelinic acid and cornutine. The sensory nerves were paralysed while the motor nerves remained unaffected.

Pellagra.

106. Pellagra has been traced to bad maize, but the nature of the poison is not so well known as in the case of ergot. A cryptogram (*reticularia usitilago*) has been found on the diseased seeds, but this fungus has been found on other diseased seeds also. It is supposed that there is some quality in the grain itself which when acted on by this fungus produces a specific poison. In 1888 over 10,000 people suffered from this disease in Roumania. Men are less affected than women. The Ministry of Agriculture in Italy provided drying apparatus for grain, and a decrease in the malady followed.

Lolium and Kodo.

107. *Lolium temulentum* has been known as a poison for many centuries and its effects were mentioned by Virgil and Ovid. The poison is probably in the grain itself. In the hill districts of the Central Provinces one frequently hears of cases of poisoning by the kodo millet, but the nature of the poison is not known.

Lathyrism compared with the other forms of grain poisoning.

108. Rye and maize are eaten regularly and by large numbers of people. It is only on very rare occasions that these grains cause injurious effects. In the diseased rye the ergot can be seen; the maize which causes Pellagra is, it appears, always mouldy. It does not appear that fresh or well-preserved maize ever causes the disease. With Lathyrism it is different. When wheat fails we find good crops of teora, and the people consume the teora shortly after it has been reaped, sometimes while it is standing in the fields. Lathyrism results when people eat in large quantity a grain which they have not been in the habit of eating in large quantity. Rye and maize have always been eaten in large quantity, but it is only on very rare occasions that they cause injury. Teora appears to cause paralysis among males in every case if eaten long enough and in large enough quantity. Enormous numbers of experiments have been made on horses, and we do not find that care has been taken to pick out a diseased specimen of the grain, yet the results seem to be uniform. French authorities have enquired carefully into the likelihood of there being a fungoid growth on the grain and they have not discovered anything of that kind. Everything seems to point to the poison being in the grain itself.

Other chronic poisons.

109. There are some other poisons which though not strictly food poisons are nearly allied to them. Chief among these are arsenic, lead and copper, which in various ways get mixed up with food stuffs or beverages, and epidemics of poisoning from one or other of these have been of frequent occurrence. These chronic poisons act on the nervous system and some of them act also on the intestinal canal. Each selects its own particular part of the nervous system—lead attacking a nerve in the arm, arsenic attacking the peripheral nerves, ergot attacking the posterior columns of the spinal cord, and the diseased maize attacking the lateral columns, so we are not so much surprised to find that the lathyrus also selects its own particular part of the nervous system, though we must remain not the less astonished to find that each poison selects its own particular area.

CHAPTER X.—Treatment, Prevention and General Summary.

Treatment.

110. The opinions on this point to be found in the literature on the subject vary considerably. The majority say it is incurable, some say it is curable; in the *Twentieth Century Practice of Medicine* we find it stated that "the old belief that recovery never occurs is not supported by more recent observations." The division of cases into the groups or stages will, however, help us to reconcile the various views. Slight cases may recover completely: those that get into Stage II may recover so far as to be able to do their ordinary work after a considerable number of months; the jaunty gait and the increased reflexes will probably remain. Those who get into the sphincter paralysis stage rarely recover sufficiently to enable them to carry on the ordinary work of a cultivator. Dr. Quinn treated 300 or 400 cases and he found strychnine of no value. Major Sutherland, I. M. S., thought strychnine beneficial. I treated a number of cases in the Khandwa Hospital for some months and tried various medicines, but the only thing which seemed to give relief was repeated blistering with iodide of mercury over the spine and over the sciatic nerve.

Prevention.

111. The cultivation of lathyrus was prohibited by the Duke of Würtemberg in 1671: Desperanches recommended its prohibition in France in 1829: it was prohibited in Allahabad in 1870, and it was prohibited in Algeria in 1881. Many of those who have had to deal with the cases in the Central Provinces have recommended prohibition. Others are strongly opposed to any such prohibition, and among these is the Hon'ble Mr. Fuller, who has had special facilities for thoroughly studying the agricultural conditions of the Central Provinces. Without going into the reasons in detail, I think that no one who understands what the crop is to the people would for a moment entertain the thought of prohibiting its cultivation in an order applying to the whole province. There are, however, some areas where the grain is not grown for feeding cattle and where it is chiefly used for issuing to farm servants, and in such places it would be advisable to exercise some sort of restriction.

Education is the great preventive.

112. Throughout the course of this enquiry there are few expressions that I have heard so often as "would I have eaten if I had known?" and this expression indicates what is the great preventive, *viz.*, education—in the schools, by proclamation or by the issue of a small pamphlet.

Criminal prosecution.

113. It is not likely that a criminal prosecution will be necessary, but if there is no doubt about knowledge then Section 328 of the Indian Penal Code, which makes it a criminal offence to administer or cause to be taken any unwholesome drug or other thing with intent, or "*knowing it to be likely that he will thereby cause hurt*," could be brought into force.*

In famine times.

114. In times of scarcity and famine teora might be used more freely, but mixed with rice or other grain. This would tend to raise the price of teora. It is the low price which cause so many to eat it as a sole diet. In families the women may eat it with less risk of being paralysed than males. Nathu (see Nimar cases) ate teora and gave his wife juari, and he is now a hopeless cripple. If she had eaten the teora and given him the juari, both might have escaped.

Agricultural.

115. In places like the south of Saugor where pure wheat is rare, the issue of pure wheat for seed by Government would be a great help to the people.

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*The Hon'ble Mr. Fuller informed me that a Deputy Commissioner in Seoni had a malguzar imprisoned after the outbreak in Seoni.

General Summary.

116. It has been shown that lathyrism is due to the consumption of lathyrus : that the disease, when it occurs in big epidemics, follows famine or scarcity : that it is chiefly confined to wheat-growing areas : that failure of wheat is an important factor in the causation : that the disease is found chiefly among the poor, and that debt is an important factor in the causation. Under certain circumstances lathyrus is a good article of diet and *it is only when the proportion reaches or exceeds one-half of the whole ration that paralysis is likely to occur.* The numerous theories which have been advanced to account for the curious distribution of lathyrism owe their origin mainly to the fact that the "*time*" and *quantity*" factors had not received due consideration. There is no proof that roasting or washing removes the poison ; there is no proof that the poison lies in the husk, or that the poison is of the nature of an ergot, or that one kind of lathyrus is poisonous while another kind is not. The mixtures are a special source of danger. The grain is specially injurious to horses.

Concluding remarks.

117. I have to acknowledge with thanks the valuable assistance received from Colonel Moriarty, I. M. S., from Mr. Sly, Commissioner of Settlements, from Mr. Burkhill, Reporter on Economic Products, from Mr. Harrison, Collector of Allahabad, as well as from several of the Commissioners, Deputy Commissioners and Medical Officers of the Central Provinces.

There is one aspect of the question on which very little has been already said. A great amount of distress has been caused by Lathyrism among those unfortunate people whose chief fault was failure to understand the nature of the food that was making them cripples for life, but I feel confident that a Government, which administered a famine of unequalled severity in a spirit of unparalleled liberality, will not allow these relics of that great famine to go from bad to worse, but will step forward and give the helping hand that is so much required.

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APPENDIX No. I.

Opinions regarding Causation.

From Irving's first paper the following quotations may be given :—

"Close to the village of Khurut Gohanse on the Sohagee Road, all the lame people from surrounding villages were mustered for my inspection on the morning of the 6th February 1857. About fifty men were present, all more or less lame in both legs ; so much disabled as to be hardly capable of motion, while others were only slightly affected. One after another was questioned and the following particulars were thus gathered. Without exception they all stated that they had become paralytic during the rains in *most cases suddenly so* ; and several stated that it had been during the night. Men who had gone to bed quite well had awoke in the morning feeling their legs stiff and their loins weak, and from that day they had never regained the use of their limbs. At first the lameness was trifling and amounted only to unsteadiness of gait and slight stiffness chiefly of the knees. After a time the muscles of the thighs commenced to ache and feel weak and also the loins. In no case did those examined admit that they had then, or ever had, severe pain either in their limbs or loins. They all ascribed their disease to their feeding principally on kesari dal, but *they seemed to imagine that in order to produce the malady, there must be another circumstance superadded, viz.*, the deleterious quality of the water during the rains. So far as could be gathered, it was not from drinking the water that they fancied they took harm, but from getting wet by it More than one dwelt on the fact of his having been exposed to rain either while ploughing or tending sheep ; and others spoke of having been working in jheels, just before they became lame, at various periods embraced between the months of July and October. The people were particularly examined and questioned as to whether they had had any symptoms of fever, or of any other disease at the time that they lost the use of their limbs, but they all said that they had not, and nothing was discovered to lead to the inference that this was not strictly true. In only one of many cases examined was enlargement of the spleen observed. Many of the men appeared to be strong-looking and their legs even, in most cases, did not seem to be much wasted, if at all so. It was stated by those affected as well as by several native officials who were interrogated on the subject that the complaint did not lead to other diseases, nor tend to shorten life, unless indirectly by preventing the individual working and thus procuring proper means of support. It was farther stated that the arms were never affected ; but there were some few cases of persons so greatly crippled that they could not walk. It was added that males were more often affected than females ; and that ryots were more liable to the disease than the zamindars, although the latter class was not exempt from it.

"As has been stated, the paralytic symptoms which prevail so extensively in Barra are, by the natives, very generally attributed to their making large use of kesari dal, the *Lathyrus sativus* of English botanists ; and is perhaps one of the most remarkable circumstances connected with the malady, that the people should be so fully persuaded that in eating this grain they eat poison, and that yet notwithstanding they have continued and will continue to do so from generation to generation. Kesari dal is not unlike gram, and is common enough in most parts of india. It is frequently sown along with wheat or barley and cut green as fodder for cattle. In Barra the kesari dal is ground and made into bread. It is sometimes mixed with other grains, such as barley ; but is more generally taken alone, the people, in fact, not being able to afford anything else. It is the cheapest grain procurable, and forms the chief support of the people from March till October. On 7th February 1857, in the bazar of Barra, wheat sold at the rate of fourteen seers to the rupee, while kesari dal was at the rate of twenty-two per rupee. It grows without labour or trouble, and on damp swampy ground that will bear no other crops. The land is merely ploughed slightly once, and the seed thrown in, or the plant sows its own seed, which germinates freely next year without further attention or care. The moist nature of the soil of Barra should be noted in connection with production of this poisonous lathyrus, for it is stated by London, in speaking of *Lathyrus cicera* causing paralysis of the lower limbs in those who live on bread partly made of it in some Continental States, that the plant grown on a strong moist soil is more injurious than that cultivated on one which is dry and light."

In the third paper Dr. Irving, in reviewing the arguments that were given by Dr. MacIntyre in favour of the exposure theory, writes :—

"In this part of India when one enquires into such cases, one is forcibly struck by what one hears, namely, that nearly all the paralysed became so during the rains ; and the natives themselves have an idea that eating kesari dal acts as a predisposing cause, and exposure to wet during the rainy months as the exciting cause of the disease. 'This, however,' says Dr. MacIntyre, 'cannot be the case in the neighbourhood of Mooltan, where the fall of rain in an entire year about equals that of a week or ten days in the Gangetic Provinces. As to Dr. MacIntyre's suggestion that this form of palsy may be produced in

the Punjab by exposure to the weather, it must be remembered that many men are equally exposed in other parts of the Punjab and of India generally, but who do not live on kesari and who are not subject to the affection. Take the Allahabad District for instance. The occupations of the people of Barra and Khyraghur across the Jumna do not at all differ from those of the people across the Ganges or in all Doab. They are equally exposed at all seasons, and in the same manner to sun, rain and cold. But there is this difference that in Barra and Khyraghur *they live largely on kesari made into bread, which they do not across the Ganges or in the Doab* ; and the result, or, at all events, the fact is, that in the two pargannas named, palsy of the lower limbs extensively prevails, while it is unknown in the Doab or trans-Gangetic pargannas."

Irving in his second paper (I. M. Science, Volume VII, page 131) gave an interesting account of the results of his enquiries from the people themselves as to the cause of the disease :—

"At Karaon I spoke with some forty or fifty cripples who had been assembled there from all the surrounding villages ; many of them called their complaint rheumatism, and appeared to imagine that it was occasioned by a noxious wind (*kharab hawa*) that blows in the rains. Others spoke of deleterious properties of the water during the rains as the cause, or, at all events, a cause of the affection. Every one who has spoken to natives about the origin or cause of any obscure disease knows how prominent are the parts that bad wind and bad water play. By means of them and of heat (*gurmee*) they appear to account for all manner of disease. Others spoke of their feeding on kesari as the cause of their palsy. Their ideas were not at all clear as to the agency of bad wind, bad water and kesari dal respectively in producing the disease in any case ; nor could I discover whether they considered that bad wind or bad water alone would give rise to palsy in one who did not use the poisonous grain. One man said one thing and another the reverse. Here, as at Barra, many spoke of the suddenness of their seizure; and several said how they had been *working in the fields during the rains when they all at once felt pain in the loins* as if rheumatism had seized them. An old man asserted, and many others told me the same thing, namely, that the disease is only produced in particular years, the theory being that it is only in those years that the *khrab hawa* prevails. There would appear, however, to be no foundation for this statement ; for of the cripples I examined at Karaon, the year that they stated they had come lame was too various to admit of the idea alluded to being true.

APPENDIX No. II.

Toxicological and Experimental.

In this appendix I have collected a number of extracts from various writers. Numerous attempts have been made to extract alkaloids, and alkaloids have been found, but there is no proof that the alkaloids which have been found are the substance which causes the paralysis. Professor Dunstan has been working at this part of the subject for some time at the Imperial Institute, London. No long continued and elaborate series of experiments to show the results of feeding different animals on varying quantities for a long time have been made.

At the end of this appendix there is a scheme for experiments which was drawn up by Mr. Stockman (Ex-Professor of Pathology, Veterinary School of Medicine, Edinburgh), and I have suggested some modifications, as some of the points have been cleared up during the course of this enquiry.

I think it will be clear from a perusal of what has been already done in regard to the toxicological part of the investigation that this part of the subject presents many difficulties.

Pronst has collected details in reard to experiments that have been made. He says:—

"Some trials made by Catterean and Giagnon on dogs, rabbits and fowls had no results. However, this was not the case with Dr. Teilleux's experiments undertaken with reference to an action for damages brought for loss sustained in consequence of eating bread containing gesse.

"He found, on analysis, in the seeds of *Lathyrus cicera*, a resinous substance, which, when administered in doses of a few grammes to rabbits, produced soon tetanic convulsions with impossibility of moving the posterior part of the body; the convulsions were more marked than the hind quarters. Death supervened on the fourth day. The author's conclusion was that the legume had an injurious action on the lower part of the spinal cord.

"Mr. Bourlier has also made some experiments with ethereal and alcoholic extracts, but on account of the time of the year, he was able to use only the seeds. According to him *Lathyrus cicera* and *Ervum ervilia* have in their hydro-alcoholic, alcholic and ethereal extracts different principles.

"Frogs and small birds were killed in some hours and at the most in two days, tortoises in 3 or 4 days, by the injection of some drops of these extracts. An injection of two drops of the hydro-alcoholic extract diluted with 5 drops of water produced very quickly in a sparrow the following effects:—Violent shivering, instantaneous and persistent diarrhœa, constant vomiting; the feathers bristled up, and the animal rolled itself in a ball; the heart beats became hurried, respiration more frequent, thirst was active; soon walking became difficult, then impossible; flying was painful and produced intense breathlessness.

"The animal died in the space of from 10 to 24 hours. The most remarkable symptom and predominant one was undoubtedly the paralysis of the claws; at first the birds walked with some difficulty, while the paralysis seemed more marked on the left side.

"With the tortoises, there was in the beginning a period of excitement characterised by irregular movements and also violent diarrabœa. Diminishing in frequency, the movements were soon followed by almost complete immobility which lasted till death. The anterior limbs were drawn back forcibly when an attempt was made to pull them out of the carapace; the posterior ones showed on the right side quite a marked resistance gradually becoming less, while on the left there was hardly any. The posterior limbs remained extended while the anterior ones were nearly all the time retracted.

"The interesting fact obtained from these experiments is that the animals before succumbing seemed to show signs of paralysis of the the posterior limbs, but there is no need of drawing attention to the great difference between these results and the symptoms observed in our patients.

"Mr. Marie at the Saltpetriere Hospital has injected some guinea-pigs subcutaneously using an alkaloid extract of the seeds in question. Up to the present, he has not noticed any characteristic signs of Lathyrism.

"Professor Vulpian had produced death in some animals, but has not succeeded in obtaining the series of symptoms seen in persons who have used gesse as food.

"The account of these experiments is interesting, but they neither throw a light on the symptoms we saw nor explain the cause of them."

Extract from a letter from Professor Church, M. A., F. R. S., to Sir Frederick Abel, dated the 26th July 1900.

I have analysed, in the ordinary way as food-grains, a considerable number of samples of Indian grown *Lathyrus sativus* seeds. Had I been furnished with a pair of samples—one known to have proved poisonous, the other known to be innocuous—a set of comparative experiments, with the view of establishing the differences between them, I would probably have given useful results.

But after reading the communications of Dr. G. Watt and Mr. J. B. Fuller, it appears to me that the scope of the investigation should be enlarged, so as to include not only the isolation of the toxic principle but also its distribution in the seed and its behaviour in a dry or moist heat, in the presence of an acid or an alkali.

That numerous alkaloids, some the poisonous, are present in seeds of species of Vicia, Lupinous and Faba, has been ascertained. It has also been found that two varieties of the same species may differ as markedly as the sweet and the bitter almond.

I think that the thorough enquiry into the chemistry of *Lathyrus sativus* needed is one which I cannot undertake. But it is an extremely interesting as well as important research, and one which the appliances of the Imperial Institute Laboratory under the skilful direction of Professor W. Dunstan might well be employed upon.

Experimental.

Professor Dunstan writing from the Imperial Institute, on 6th October 1902, acknowledged the receipt of a sample from Seoul, sent by the Reporter, Economic Products, and went on to say:—

"I may take this opportunity of mentioning that our examination of this subject, which has proved to be an exceedingly difficult one to determine, has now been extended on the physiological side, and a number of experiments have been made with animals in order to identify, if possible, the particular variety of grain which is poisonous, and to clearly define the symptoms of poisoning so that they may be recognised in the physiological effects produced by substances separated in the process of chemical examination.

"These experiments necessarily consume a large quantity of material, and I now have to ask whether it would be possible to provide one or two bushels of the grain reputed to possess poisonous properties so that the investigation on the physiological side may be continued *pari passu* with the chemical enquiry."

The following extract is taken from Vaughan's Twentieth Century Practice of Medicine:—

"The fact that vetch seeds are poisons to many of the lower animals has been abundantly demonstrated by direct experimentation. Gabory fed 18 ducks with vetch seed ground with corn. All the birds died on the first day, with symptoms of intoxication, somnolence and paralysis. Similar experiments with like results, were made with geese, pigs and pigeons, and were found to be less susceptible and indeed were supposed by this investigator to be wholly immune to the poison. The statement is made that animals are never affected by eating the green plant. This is denied by some, and Ferrarisi states that he saw 18 hogs paralysed in their posterior extremities after eating green vetch."

Remarks:—It would be a very remarkable thing if ducks could be killed in one day by Lathyrus. I should doubt this. It is not likely that animals would be fed on the green plant for a long time. The green plant is largely used for feeding bullocks in the Central Provinces, but the green plant would only be available for about six weeks.

Extract by Mr. Stewart Stockman.

"Article by McCall in the Veterinarian, 1886. Fifteen cases in horses, 14 were the property of one firm. I can see no evidence that sex modified the affection (S. S.) 8 cases fatal; death came on suddenly when the animals were making strong efforts; they had shown symptoms of distressed breathing for some days before, especially when made to work: death was apparently due to suffocation (the suffocation was due probably to partial laryngeal paralysis). If animals are left quiet they do not seem to die (S. S). In undetailed cases (1) of 24 horses in one stable 13 were affected in various degrees; no fatal cases mentioned; (2) of 25 affected, paraplegia not referred to all: tracheotomy relieved symptoms and averted death: the grain of course was stopped; the exact quantity not known, but it is distinctly stated that in one stud a certain number of horses received the lathyrus mixture after boiling, and these did not suffer, while others receiving the raw lathyrus did. (In view of the evidence from French and German writings I doubt the accuracy of this observation)—(S. S.).

British Medical Journal, September 2nd 1899.

Lathyrism in Algeria.

Dr. H. Blaise has recently published the result of some interesting researches into the etiology of Lathyrism. Bonrlier, some time ago, asserted that the condition could be produced not only by *Lathyrus sativus*, but also by *Lathyrus cicera*. He injected alcoholic extracts of the bean into sparrows and tortoises; the result was death in 20 to 40 hours, with paralysis of the hind limbs. Dr. Blaise gives details of experiments of his own on the same lines which do not give at all the same results. He used glycerine extracts and is disposed to attribute his (Bonrlier's) results to the injection of alcohol. Rabbits and guinea-pigs do not react at all. One pigeon showed some weakness of the extensors of feet for a few minutes; two doves were seized with vomit and inability to use the lower limbs; two sparrows had the legs more or less affected but did not vomit though one died; tortoises were affected by an alcoholic extract, but not by a glycerine extract.

Dr. Blaise also fed various animals exclusively on djilben, as the seed is called in Algeria, but without result. He states that a planter's wife told him that one year all her fowls died; she attributed their deaths to djilben, which however, fowls can as a rule eat with impunity. The same person fed a pig on djilben, and the animal developed paralysis of the hind limbs.

Mr. Hankin, Chemical Examiner, writing on the 9th September 1899, to the Civil Surgeon, Saugor, said:—

"I have experimented with the bag of teora dhal therein referred to. I have no more succeeded in finding proofs of the presence of a poisonous substance than in the case of the specimens previously sent to me. Two monkeys have been fed with the dhal in question for several weeks without any effect on their health."

Dr. Leather, Agricultural Chemist, wrote:—

"In reply to the enquiry contained in your demi-official of 19th instant, I am sorry to say that I cannot give you any information of a definite nature regarding the alkaloid in kesari.

"I received in 1895 samples of two varieties from the Central Provinces, one called 'lakh,' the other 'lakhori.' Both seeds are grey, but one is larger than the other. The former, which is the large one, is said to be poisonous, the other not so. I extracted from each an alkaloid which reacted with re-agents in the same manner and had the same odour, but it seems to be somewhat readily decomposed, at any rate in the time I had at my disposal I failed to get it pure. I thought I should have had time to go more thoroughly into it, but have not up to the present, and now that I am leaving India at the end of this year I shall probably not be able to do anything more at it. Perhaps I may take it up when I get home."

The following account of Astier's analyses and experiments are taken from Vaughan's Twentieth Century Practice of Medicine, Volume XIII, page 72:—

"Astier extracted the seeds with dilute alcohol, keeping the temperature during the process of extraction below 50° C. Two decigrams of this extract were used in injecting subcutaneously a dog weighing 8·5 kgm. Ten minutes later there was noticed a trembling of the posterior extremities which ceased after half an hour. Twenty four hours later a second injection containing 6 dgm. was administered to the same animal; the trembling was now more pronounced and followed by partial paraplegia. From this condition the animal slowly but completely recovered. This experiment was repeated on three other dogs with like results. Astier satisfied himself that the seeds from which this extract was made were free from any contamination and that they did not contain any mould. The same investigator obtained from the seeds of *Lathyrus cicera* a volatile alkaloidal body to which he gave the name of *Lathyrus*. He states that this substance is of doughy consistence, strongly alkaline, insoluble in water, slightly soluble in ether, but freely soluble in chloroform and easily volatile. It was found to be readily soluble in dilute hydrochloric acid. Its hydrochloric acid solution responded to the general alkaloidal reactions. On the evaporation of this solution the residue was found to consist of needles, and these on being heated on platinum foil burned without residue. Unfortunately there is no record of physiological experimentation with this substance and consequently there is no evidence that it constitutes the active agent of the seed. Some observers stoutly maintain that the seeds of lathyrus are harmful only when decomposed or when they contain some parasitic growth similar to ergot; others believe that the poisonous symptoms are due to the mixture of these seeds with those of other plants such as a gostemma, githago (comcockle) and lolium temulentum (darnel)."

M. Pierre Marie writes:—

"Professor Brunelli has fed rabbits with the flour of *lathyrus cicera*, but these never lived long enough to enable him to observe the lesions produced by the chronic poisoning.

For our own part we have, in collaboration with Mr. Londe, Chief of the Chemical Laboratories at the Clinique of the Salpetriere, commenced a series of experiments on the action of lathyrus on animals. Our first ones were directed to this object to know (1) if there exists an alkaloid in the seeds, (2) if the symptoms observed are to be referred to the action of this alkaloid.

"As regards the first part of this question, we can answer now in the affirmative; there does exist an alkaloid in lathyrus seeds, there are perhaps several of them, as we shall see shortly.

"The following are the methods by which we have succeeded in discovering the presence of the alkaloid :—

(1) Having reduced to flour some seeds of *Lathyrus cicera*, we boiled this for some hours in water with a little hydrochloric acid, and in the decoction so obtained we have recognized, among other substances, the presence of albumin glucose and a substance precipitable by tannin, and by Winkler's re-agent (iodide of potassium and bichloride of mercury); the precipitate so obtained was re-dissolved by the action of heat or by alcohol. These reactions, it is well known, are characteristic of the alkaloids. In order to isolate the alkaloid or alkaloids in our decoction, and procure a solution of them, our further proceedings were as follows. Having noticed that the liquid, filtered through animal carbon, gave up to the latter any alkaloids in it, we have by agitating the charcoal with alcohol redissolved the alkaloid retained by it, after having previously washed the carbon with distilled water to take away the glucose. Then after evaporating the alcohol a residue was obtained, which in water with hydrochloric acid, gave all the reactions possible with Winkler's re-agent.

(2) Having placed in a retort some flour of *Lathyrus cicera* with a concentrated solution of caustic potash, we distilled the mixture in a sand bath and obtained a brownish liquid with a very strong empyreumatic odour. This alkaloid is volatile, and whether it is the same given by the first method of preparation, we are not in a position to say, nor can we say further whether *Lathyrus cicera* contains several alkaloids or one only.

We have begun some experiments with guinea-pigs, injecting them subcutaneously with the solutions obtained as above, but up to the present, have seen none of the characteristic signs of lathyrism. We shall continue these experiments and repeat them with other animals of different species, so as to determine if the affection caused by *Lathyrus cicera* be due to the alkaloid found in it or to some other substance.

M. Pierre Marie, in a paper "*Des Manifestations medullaires de l'ergotisme et du Lathyrismec*," wrote :—

"As long ago as 1840 Dr. Feillenx is said to have extracted from lathyrus seeds a resinous substance, which administered in a few gramme doses to strong rabbits, produced soon inability of moving the hind part of body and tetantic convulsions, particularly in the hind limbs; death took place on the 4th day."

Scheme for experiments.

At the commencement of this enquiry Professor Stockman, M. R. C. V. S., drew up a scheme of experiments. Many of the points which were then doubtful have been to a certain extent cleared up during the enquiry. Stockman's scheme is given below and some remarks will be entered under each of the eight headings in this scheme.

I.

Is every kind of teora equally poisonous? This could be settled by obtaining the different varieties of grain from districts in which Lathyrism is prevalent and feeding animals exclusively with each variety.

Such experiments ought also to determine the length of time necessary to produce the disease.

Once the time necessary to produce the disease is determined, it will be possible by further experiment to establish whether by withholding the grain after a certain quantity has been consumed the disease can be arrested.

That again should decide whether the poison of teora is cumulative, or if only a prolonged action on the nervous system is necessary to bring on the symptoms.

The spinal cords and nerves of the affected regions could be submitted to a histological examination with the view of determining the nature of the injury.

It was thought that the small kind of teora was non-poisonous, but it has been shown that this idea was not founded on a sound basis. The time necessary to paralyse an adult human being is from two to three months as shown in the Nimar cases. The time required to cause paralysis in a horse is about a month. The evidence in regard to cattle and buffaloes is not so clear, but they probably would be paralysed after eating the grain for a long time. This point might be cleared up by experiment, *e. g.*, if four bullocks were fed on one seer, four on two seers, four on three seers, and four on four seers daily. A few milch cows might also be fed on the grain, beginning with a large quantity, say three seers daily, stopping the grain as soon as two of them show signs of paralysis and watching the effect. After an interval of two months those that were not affected might be fed on a smaller quantity, say, two seers a day. A similar experiment might be afterwards carried on with buffaloes, both male and female.

II.

Is the poison located in any particular part—the husks for example—or does it pervade the whole grain? This could be settled by feeding two lots of animals, one on the husks and the other on the meal of the same sample of grain. If it be found that the poison really lies in the husks, a simple method of remedying the evil suggests itself.

The opinion that many held, that the poison lies in the husk, was proved to be wrong by the cases which were found in Mungeli (Bilaspur), but it would be well to have that evidence confirmed by feeding one set of animals on the grain without the husks and another lot on the husk mixed with gram or some grain which is known to be innocuous, so as to make the whole mass palatable.

III.

Can the poison be extracted by water? It has been said that soaking the grains in water for some time renders them harmless. Water extracts could be made from the grains and given to one set of animals, while another lot are fed on the grains from which the extracts have been made.

The evidence in regard to the value of soaking the grain in water has been shown to be of no value, as the grain which was treated in this way was used as dhal and was only taken in small quantity. I do not think it would be worth while for the present making any experiments on these lines.

IV.

It is said that an oil can be obtained from teora which acts as a drastic purgative. Is this statement correct? If so, is the paralysis substance contained in the oil? The oily constituents of the grains should be extracted by pressure or after the sohxlets method and is effects tried on animals.

I had some seeds crushed in the common country oil-mill, but could not succeed in obtaining any oil. It has been stated somewhere that the amount of oil is only ·75 per cent., and probably the best way to have the oil extracted would be by the sohxlet tube. It would, however, be a difficult matter to get a sufficiently large amount of the oil to make any elaborate experiments with the oil. Its effects might, however, be tried on small animals.

V.

It is said that the poison is volatile, and can be driven off from the grains by a thorough system of cooking. This is a most important point to settle, as it indicates a simple remedy, and yet there is no reliable information on the subject.

To decide it one set of animals should be fed on thoroughly cooked teora and another lot on the same sample of grain in the raw state. The effects of the volatile products of distillation could also be tested on animals.

This experiment might be carried out after the effects of feeding the cattle and buffaloes had been observed, or one lot of horses might be fed with the raw grain and another lot with grain which had been thoroughly cooked. That a slight heating has no effect in preventing paralysis has, I think, been fairly well proved by the evidence from the cases which were found in Mungeli. The grain was cooked as porridge and yet the persons who ate it got paralysis.

There seems to be a prevalent idea that there is a volatile alkaloid, but it is not clear on what grounds this idea has been based. If it is found that animals fed on grain which has been well roasted or well boiled are not paralysed, an attempt might then be made to collect the distillate and try its effects on animals.

VI.

Is the noxious principle of the teora due to contamination by fungi or microbes? This subject could be enquired into by means of culture experiments and inoculation of animals.

The evidence collected during the enquiry, although it does not afford absolute proof, still, I think, it is sufficiently strong to indicate that it is extremely improbable that the poison is the result of the action of microbes. It would be well then to use in the experiments grains that are as far as possible sound. I say as far as possible, for it is difficult to get lathyrus that has been kept for any length of time free from weevils. Weevils apparently attack lathyrus more quickly than any other pulse. The weevil is larger than the wheat weevil and has two white specks on the back.

VII.

Is the poison an alkaloid and can an antidote be found?

Professor Dunstan of the Imperial Institute has been working at this question for some time. I wrote to him some time ago asking for information as to what had been done, but have not yet received a reply.* This part of the investigation might be left till the results of the investigation which he has been conducting are known.

VIII.

Can animals be rendered immune to this vegetable poison as in the case of ricin and abrin, and if so, has the serum any curative effects?

In the event of being able to obtain the poison in concentrated form an attempt would be made to immunise animals against it by injecting small but ever-increasing doses. Should immunity be established in this way, the preventive and curative effects of the animal's serum could be tried on human beings or animals. There are many natives who have eaten teora for years without bad results, and it is not impossible that they acquired immunity by taking small quantity in the first instance, but, of course, there are other possible explanations.

I had two pigeons fed on teora. After a month one of them showed signs of paralysis. A few days afterwards the other showed some weakness of the legs, but after a few days it recovered and continued eating teora for seven months and without showing any ill effects. This one instance proves nothing, but suggests the advisability of continuing such experiments with a view to determining whether an immunity can be established in any animals or birds.

The experiments with serum might be omitted for the present.

It will be important to find out whether there is any small animal that is always susceptible to the influence of lathyrus as a guinea-pig, or rabbit, or rat. If such an animal could be found, then the effects of boiling could be easily tested; or if an alkaloid is extracted the effect of the alkaloid extracted in a particular way could be tested. As far as we know at present the horse seems to be the animal that is most constantly susceptible, but if a small animal can be found that is equally susceptible it would have the advantage of being less expensive.

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* The following is an extract from a letter since received from Wyndham R. Dunstan, Esq., Director of the Imperial Institute. It is dated 28th September 1903:—

"The results of the chemical investigation have been so far entirely negative, and no positive result has been obtained in the series of feeding experiments with guinea-pigs, which could not, however, be completed for want of material.

"The conclusion we reached is that the poisonous properties of the seeds are not due to a volatile alkaloid or to any ordinary chemical poison. There remains, however, the doubt as to whether all samples of the grain are poisonous and whether the samples have always consisted of the poisonous variety.

"I have therefore recommended that the poisonous variety of the grain should first be ascertained in India by a long-continued series of feeding experiments with animals, and at the same time, if possible, the location of the poison in the coat, or other portion of the grain determined. Perhaps your enquiry may settle these questions and thus allow the chemical investigation to be continued with some chance of success.

"I am satisfied that there is a close connection between Lathyrism and the "Loco" and "Nenta" disease of America and South Africa, and the "Indigo" disease which affects sheep in Australia (see "Plants Poisonous to Stock," Department of Agriculture, Sydney, N. S. W.) All these diseases are attributed to the consumption of leguminous plants.

"The enquiry of which you have sent me an outline seems to be well adapted to clearing up a number of disputed points.

"No satisfactory conclusion is likely to be reached except by a combination of feeding and chemical experiments. The latter work we have every facility for doing here if provided with authentic material in sufficient quantity. The feeding experiments are best conducted in India."